DEVELOPMENT OF A METHOD FOR ASSESSING THE ORGANIZATIONAL, CULTURAL, AND POLITICAL CONSIDERATIONS AFFECTING THE INSERTION OF SILOMS INTO THE MoD

THESIS

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AFIT/GLM/ENS/02-12

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Report Documentation Page

Report Date	Report Type	Dates Covered (from... to)
26 Mar 02	Final	Mar 2001 - Mar 2002

Title and Subtitle Development of a Method for Assessing the Organizational, Cultural, and Polictical Considerations Affecting the Insertion of Siloms into the MoD	**Contract Number**
	Grant Number
	Program Element Number
Author(s) Capt Samir Mustafa, BRAF	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) Air Force Institute of Technology Graduate School of Engineering and Management (AFIT/EN) 2950 P Street, Bldg 640 WPAFB OH 4543-7765	**Performing Organization Report Number** AFIT/GLM/ENS/02-12
Sponsoring/Monitoring Agency Name(s) and Address(es)	**Sponsor/Monitor's Acronym(s)**
	Sponsor/Monitor's Report Number(s)

Distribution/Availability Statement
Approved for public release, distribution unlimited

Supplementary Notes

Abstract
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Subject Terms	
Integrated Logistics Information System, Project Risk Assessment, SILOMS, Risk Taxonomy, Information System Implementation Project	
Report Classification unclassified	**Classification of this page** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** UU
Number of Pages 124	

AFIT/GLM/ENS/02-12

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THESIS

Presented to the Faculty

Department of Operational Sciences

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

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March 2002

AFIT/GLM/ENS/02-12

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Acknowledgments

I would like to thank Major Stephen Swartz, my thesis advisor, and readers Major Stan Griffis and Dr. Alan Heminger. Without their precious recommendations and patience this research could not be accomplished. Their support gave me confidence and motivation. Also, I would like to thank those who work in Brazilian Ministry of Defense, in the Logistics Institute of Aeronautics and in GT-SILOMS. These people gave me support by their friendship and willingness to help in my research. Just to name a few, they are Lt Col Jorge dos Santos Barros, Lt Col Antonio Cesar Santana, Lt Col Mauro Hernandes Rodriguez, Maj Ulisses Buonasser, Major Paulo Henrique Sbrissia, Capt Rita de Cassia, Capt Flavio Marcio de Souza and Capt Fabricio Saito. Special thanks to Janice Farr for providing help in formatting and correcting the text. To my little daughter Amina and my family, all I have to say is that they are the best I could wish. One last thanks goes to Juliana, for her unforgettable support.

Samir Mustafa

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Abstract

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DEVELOPMENT OF A METHOD FOR ASSESSING THE ORGANIZATIONAL, CULTURAL, AND POLITICAL CONSIDERATIONS AFFECTING THE INSERTION OF SILOMS INTO THE MoD

I. Introduction

General Issue

In the past decade Brazil has been reengineering processes relating to government bureaucratic organizations and the economy in order to prepare the country for globalization and shrinking budgets. During the last two presidential mandates, from 1994 to 2002, Brazil's government has led structural changes to assure the country a competitive place in the new world scenario. Changes have been made within all government departments' structure to decrease expenditures and improve efficiency while performing an increasing number of functions to deal with the changing environment.

The defense system administration has implemented a new organizational structure combining the former three separate ministries for each branch of military services and other defense organizations into a single Ministry of Defense (MoD) - see Figure 1. The former organizational structure was considered inefficient, expensive, and was not integrated across the services. Until 1995 Brazil's defense system was based upon each service having its own Ministry in addition to an overall Ministry of the Major Staff of the Armed Forces. Each armed force and the major staff had its own bureaucratic structure and was responsible to perform all affairs related to a Ministry. This proved to be highly expensive and inefficient. A lack of joint

effort was clearly visible, as each service could be developing a program or weapon system acquisition without considering the effort already being done by other services. Duplication of efforts occurred, and many opportunities to improve joint programs were lost during the past decades due to the old defense organizational structure.

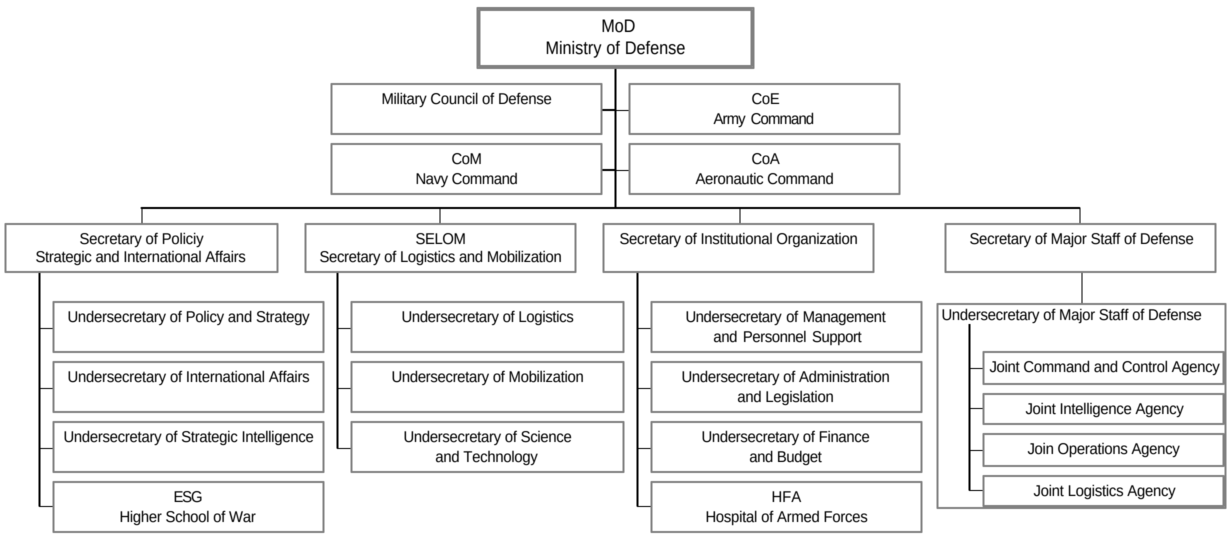

Figure 1. Brazil's Ministry of Defense Structure.

As the new concept of defense organization was being implemented problems came up under the new MoD structure. As a result of the new scenario, specific defense system regulations had to be developed while old ones were revised as the armed forces began to jointly manage their assets. New agencies were created while others were combined. New civilian administrative roles and positions, formerly occupied only by military personnel were created; mixing military and civilians in the MoD. This changing scenario brought many new needs. One newly recognized issue was the lack of specific information systems to support the

strategic decision process concerning weapon systems acquisition within the defense organizations. Another issue was the lack of an Integrated Logistics Information Database System (ILIDS) that could link each service and its related organizations to the MoD with relevant logistics information concerning the acquisition and support of weapon systems.

Almost concurrently with these changes and needs, the former Brazilian Ministry of Aeronautics (MoA) - see Figure 2 - started a program in 1993 aiming to achieve an integration of the information systems within the Brazilian Air Force (BAF) Materiel Command (COMGAP) - see Figure 3. The program, now under responsibility of the Aeronautical Command (former MoA), called Integrated System of Logistics Materiel and Services (SILOMS), integrates in a single corporate database system for all logistics information related to maintenance, supply, and transportation within the COMGAP. The overall goal of the system is to provide information to support the logistics decision makers at all three decision levels within COMGAP's organizations: operational (bases, squadrons and depots), tactical (sector materiel commands) and strategic (materiel command). By the end of 2002 the system is expected to improve the capability of COMGAP's organizations to control and manage assets, including weapons systems and related equipment, as well as track needs during a systems' life cycle. The system will also provide a clear vision of the movement of materials within the depots and related bases. Another important feature of the system is to allow a variety of queries in the corporate database to collect statistical data that could help the measurement of key performance parameters related to maintenance activities as well as reliability and availability of the assets being controlled.

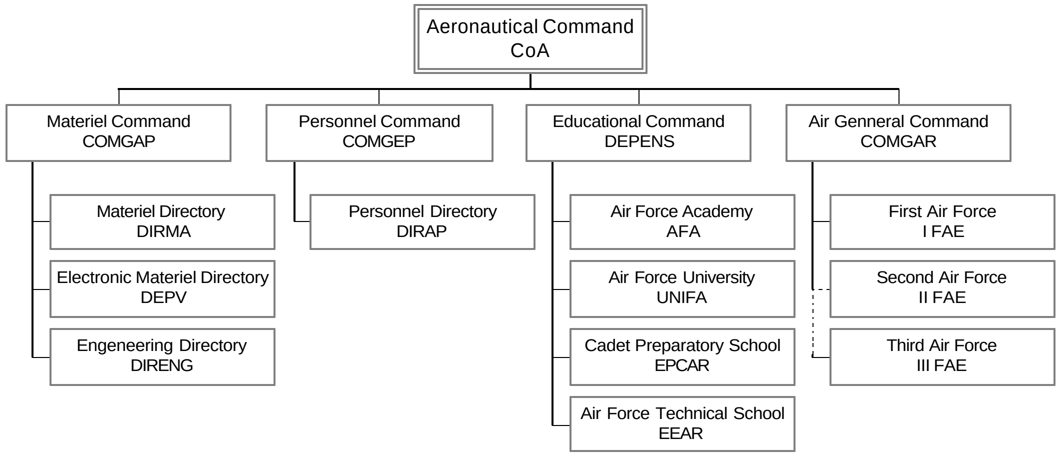

Figure 2. Simplified Brazilian Aeronautical Command Structure

By the end of 2003, SILOMS is supposed to link one hundred and eighty organizations and more than two thousands workstations in a common network. With some adaptations, the system has the capability to fill in the gap that exists in the MoD's Logistics and Mobilization Agency (SELOM), by allowing integrated management of all needs within the military in supporting their weapon systems. SILOMS may be used, for instance, in helping identify similar parts needed by all defense organizations and allowing SELOM to employ a consolidated acquisition of supplies, thereby promoting savings and improving the efficiency of the weapon system acquisition process and their associated life cycle.

Brazil is rethinking its own government structure in light of shrinking budgets while the move to globalization is taking hold. New ways of management and control over government activities and expenditures have to be found to improve the efficiency of all departments and agencies, while at the same time improving their activities. In this situation, SILOMS has arisen to be a possible solution to some problems facing MoD. This research will present a study

about the feasibility of using SILOMS as a solution to fill in the needs of a logistics information system for MoD's agency SELOM.

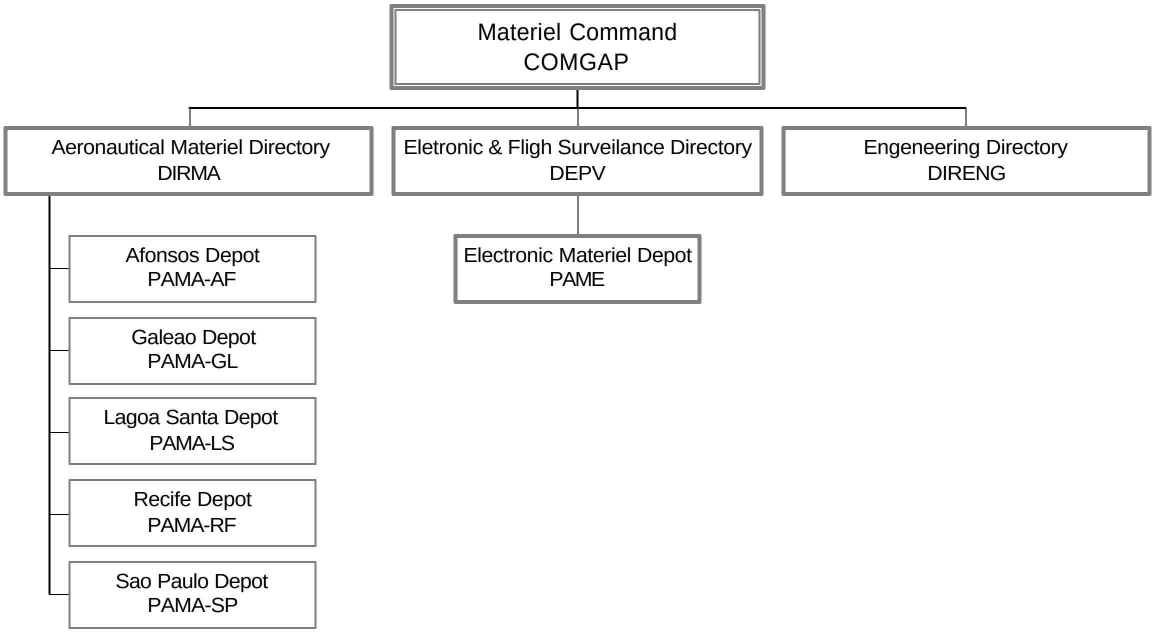

Figure 3. Simplified COMGAP structure with subordinated Depots

Background

When an information system is developed, the analysis of the user's needs lead to very specific requirements that fit a narrow scope environment in which the system is supposed to operate. The users of a system in an organization may be satisfied with the system's features that have indeed been developed to fit their needs. On the other hand, problems may appear when trying to operate a system in an environment that was not foreseen, or where the users have not been involved in the requirements analysis during the beginning developmental phases of the system.

Even when trying to adapt an existing information system to a similar environment or organization, some considerations related to the new organizations can lead to an unsuccessful implementation or provoking strong users' opposition in using the system. For instance, SILOMS's has experienced success since the beginning of 2001 when it was implemented in six Aeronautical Depots Level Maintenance Center (PAMA), one Electronic Depot Level Maintenance Centers (PAME), and related air force bases linked with an integrated database system. The success of the implementation was only possible after solving many problems that had come up when organizations were being analyzed in an effort to get the overall picture of the COMGAP logistics activities. Constraints such as, organizational and cultural differences, political, resources and environmental issues as well as internal processes related to logistics showed to be a challenge that faced the analysts even in similar COMGAP's sectors. An extensive study about the way to perform tasks in the organizations took place to allow standardization of processes; and, at the same time, meeting users' needs. The SILOMS program brought attention to the fact that even in the BAF materiel command sectors that were supposed to perform tasks with similar processes, that was not always the case. The degree of standardization of process within COMGAP's sectors was a key issue to the success or failure of the SILOMS program. Fortunately, a considerable degree of standardization has been achieved within the COMGAP agencies, after considerable efforts to perform changes that were directed to all levels of management within the materiel command.

Since 1993 when SILOMS started to be implemented, many problems such as cultural differences and different ways in performing activities have challenged the analysts and also the

COMGAP's administration in trying to standardize the processes and tasks related to logistics support within the materiel command sectors. The success of SILOM's implementation was in great part due to the successfully standardization of the processes and activities that took place in all development phases of the integrated information system. By the end of 2003, SILOMS is expected to link and support the operation of one hundred and eighty organizations and more than two thousand workstations in a common network of the BAF.

Problem Statement

In order to handle its obligations, the new MoD's agency SELOM will need an information system capable of managing logistics data and information from all military services and security forces.

Considering the problems described in the previous sections, we can expect that SELOM (that needs an information system to meet the needs not only of BAF, but also the Brazilian Army (EB) and Brazilian Navy (MB)) will face challenges in adopting a new integrated information system - even if it chooses to adopt SILOMS. To develop an information system with a corporate database, the degree of standardizations within the organization can influence the success of such implementation. It is expected that a careful study of the differences related to logistics in the services within the MoD take place before starting the implementation of such system. Also, if SELOM decides to use SILOMS, a study about the constraints such as organizational and cultural differences, political, resources and environmental issues is needed. Otherwise, the same problems that challenged the SILOMS implementation within the BAF are expected to occur when attempting to use it as a base system to the MoD's agency SELOM.

The implementation of an integrated information system has inherent challenges. Differences in organizations and cultures, political, resources and environmental issues or in the way tasks are performed, are key issues to be observed in attempting to do so. The same is applicable when trying to adapt an already existing system to fill in the need of another organization. In such new environment, a key issue is to assess the feasibility of proceeding with an adaptation of an existing information system or if it is better to build a completely new system. If SELOMS chooses to use the SILOMS, what constraints exists that can threat the success of its implementation in the MoD?

Research Objectives and Questions

The objective of this research is to provide a method to measure the effort and feasibility of using SILOM's functions in the SELOM's environment. In this way, it will contribute to the integration of the logistics management and the expected benefits that such a system can provide for the Brazilian MoD's agency. The research is undertaken to answer research questions about the feasibility of adopting the SILOMS as a base logistics information system, or whether it is better to start the implementation of a completely new system.

Research Questions

The implementation of an integrated information system has inherent challenges as discussed in previous sections. SELOM has decided to rely on a logistics information system to better perform its activities. Is it feasible to use SILOMS as a baseline system to manage logistics needs and assets within the armed forces and MoD?

To assess the feasibility of doing so requires a study and a methodology to determine the constraints suitability of SILOMS's functions to fulfill other services needs. By doing so, the research will offer SELOM a tool to support the decision of whether it is better to develop a new system or whether take the advantage of using an existing one. How to assess the feasibility and risks of the implementation of SILOMS in the MoD?

Investigative Questions

A top-down approach helps to answer the research questions in the way that allows breaking the research questions into more specific questions to facilitate the analysis. Specific questions have to be answered in order to assess the feasibility of using SILOMS in the MoD environment:

- What are the factors critical to the successful implementation of SILOMS in the MoD?
- What is an appropriate method available to assess or predict risks involved in the implementation of SILOMS in the MoD?
- How would we quantify the degree of risks in order to help the decision making process of adopting SILOMS in the MoD?
- Can a probability of success be obtained from this methodology?

By answering these questions the research will consolidate information to serve as an input to the decision makers for assessing the feasibility of using SILOMS as a baseline system to SELOM agency.

Data Sources and Analysis

To answer the research and investigative questions it is necessary to understand the constraints that apply when implementing a new information system in organizations. The objective and subjective data of the constraints will be gathered from personal interviews and questionnaires submitted to key personnel in MoD's agencies and systems analysts from the Integrated System of Logistics Materiel and Services Task Force (GT-SILOMS). The interviews will be based on a questionnaire proposed originally by a technical report of The Carnegie-Mellon University's Software Engineering Institute and modified by the researcher to fit the specific circumstances that apply to this research. An evaluation about the extent and the feasibility of applying SILOMS to other armed forces and MoD can then be performed. The data available will then be tabulated using a rating scale and rank order procedure, by relevance, for the questions asked for the interviewees. In this way the research will provide a way to quantify a typical qualitative assessment in order to better help the decision makers to evaluate the implementation of SILOMS in the MoD.

Scope/Limitations

In a study to assess the feasibility of using an existing information system in different organizational environments it is necessary to understand each of the of the constraints that affects the implementation of the system, and also the specific needs of the new organization where the system is supposed to operate. In such a study, the data tables, functions and internal routines of the system have to be analyzed and a test of fitness to the new environment has to be performed. SILOMS has more than 1,400 functions subdivided under six major logistics

functions: personnel, facilities, supply, maintenance, transportation and independent. These major functions enclose other functions modules as seen in the Function Break-down Structure (FBS) in Figure 4.

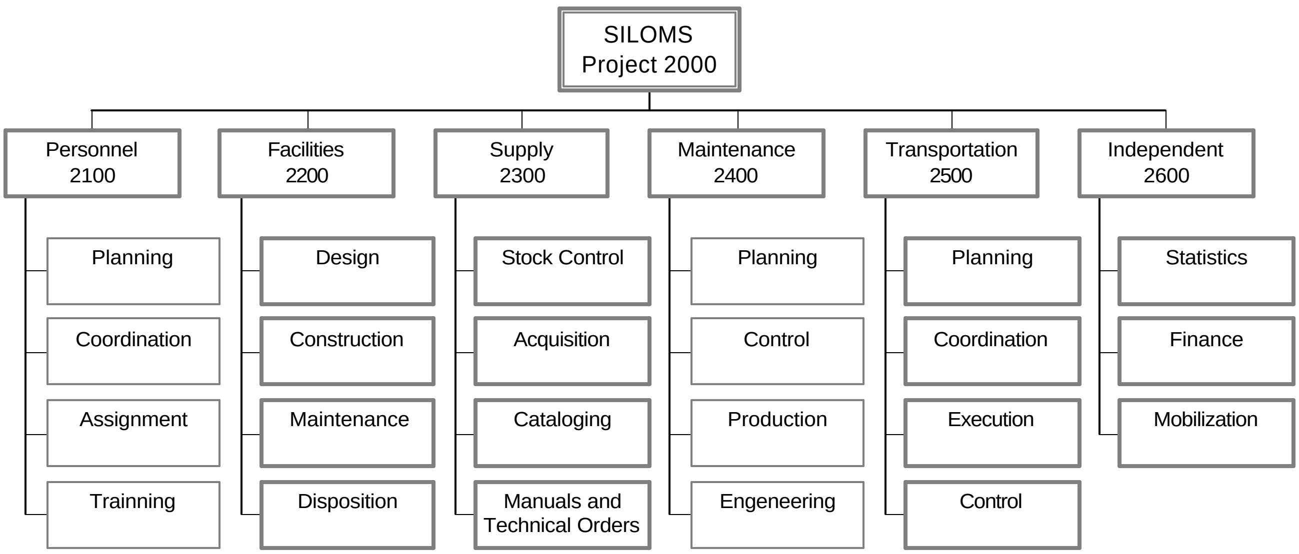

Figure 4. Simplified SILOMS's FBS - Logistics functions. COMGAP's Taxonomy

This study assumes that it is technically possible to use and/or adapt SILOMS's functions to satisfy the MoD's needs. Then, factors as contracting, resources, program interfaces constraints, or other constrains of this nature, will not be explored. The focus will be on the organization, cultural and political aspects that can threat the successful implementation of SILOMS in the MoD's agency SELOM. These aspects will only be explored within middle and high-level managers of MoD's agencies. The method proposed in this study could be used to a more complete assessment enclosing other factors, constraints and personnel in future studies.

Chapter Summary

This chapter presented some issues that Brazil's MoD agency SELOM is facing in the integration of the armed forces logistics information system. BAF's logistics information system, SILOMS, has been described as a potential system that can fulfill SELOM'S needs. Problems that arise in developing or adapting an information system were described and some inherent challenges were highlighted. Questions that have to be answered to assess the feasibility of using SILOMS as a baseline system for the MoD environment were described. Data source and analysis were presented. Finally the scope of the study was presented, limiting the study to the organization, cultural and political factors and constraints that could threat the successful implementation of SILOMS in the MoD.

In Chapter II a literature review about the methods and concepts used to perform this study are presented. Chapter III will present the selected methodology to perform the study, while Chapter IV will present the data obtained and the required analysis to assess the feasibility of the implementation of SILOMS in the MoD's agency SELOM. The last chapter will present the conclusions and recommendations when applicable.

II. Literature Review

Introduction

Before assessing the feasibility of using SILOMS in the MoD's Agency, it is necessary to gather relevant information concerning the methods available in making interviews and also about risk assessment and identification methods. Also, a literature review about project management and inherent risks associated is required since the nature of the work might fit the definition of a project.

Then, the literature review will first explore the definitions and characteristics of a qualitative research as well as considerations about surveys and the use of questionnaires, interviews and Likert's scale, that will apply to the present study. Second, a literature review of the relationship between projects and risks, as well as the appropriateness of using project management approach in activities with inherent risks associated will be discussed. Third, the chapter will discuss and present the concepts of managing risks in software development project and available risk analysis methods. Fourth, the Taxonomy-Based Risk Identification Method (TRI), a method to risk identification in software development environments, and the derived Taxonomy-Based Questionnaire (TBQ) will be presented. Finally, a chapter's summary will briefly list the concepts and theories discussed in Chapter II.

Qualitative Research

This section presents the definition and characteristics of a qualitative research and the relationship with this study. Then, the section will present the situations where the qualitative research study may apply and its five common types. The last part will present the characteristics of surveys, related questionnaires and interviews, and the Likert's scale.

Since the focus of this study are the organization, cultural and political aspects that can threat the successful implementation of SILOMS in the MoD's agency SELOM, one can expect that many dimensions and subjective aspects may appear when performing the study. A qualitative study and its methods have the advantage of going in depth in the problem by allowing more flexibility to the researcher in a real world environment or natural setting with inherent subjective aspects. Then, when subjective aspects are present, a qualitative research is best recommended. And in order to get a complete understanding of the constraints that may occur in the implementation of SILOMS in MoD, a qualitative research and its methodologies has to be employed. As stated in Leedy:

> The term **qualitative research** encompasses several approaches to research that are, in some respects, quite different from one another. First, they focus on phenomena that occur in natural settings – that is, in the "real world." And second they involve studying those phenomena in all their complexity. Qualitative researchers rarely try to simplify what they observe. Instead, they recognize that the issue they are studying has many dimensions and layers, and so they try to portray the issue in its multi-faceted form. (7:147)

Different from quantitative research, which is more appropriate for studying physical events, the qualitative research is more adequate to explore human events that have inherent subjectivism and where multiple perspectives can be held by different individuals. These

multiple perspective, in turn, may have equal validity or add value to the data analysis and conclusions. Furthermore, these multiple perspectives and revealing their natures end up of being one important goal of qualitative studies.

> Furthermore, many qualitative researchers believe that there isn't necessarily a single, ultimate Truth to be discovered. Instead, there may be multiple perspectives held by different individual, with each of these perspectives having equal validity, or truth (Creswell, 1998; Guba & Lincoln, 1988). One goal of a quality study, then, might be to reveal the nature of these multiple perspectives. (7:147)

In qualitative studies, more often the researcher formulates only general problems and asks general questions about a phenomenon he is studying. This, although, doesn't mean that the problems and questions remain vague. As the researcher proceeds with the study, the nature of the phenomenon being studied becomes more understandable and the researcher becomes better able to ask specific questions.

> These research problems and questions do not remain so loosely defined, however. As a study proceeds, the qualitative researcher gets an increasingly better handle on the nature of the phenomenon under investigation and so becomes increasingly better able to ask specific questions. (7:148)

In general, qualitative studies do not help the researcher to identify cause-and-effect relationships to answer questions about whether a cause or some specific circumstance has provoked the effect. If such answers are needed, the quantitative approach is needed. The decision when to choose to proceed with a qualitative approach depends upon the purpose of the study. Typically qualitative studies serve one or more of the following purposes, according Peshkin reported by Leedy in Practical Research – Planning and Design (7:148):

- *Description*. They can reveal the nature of certain situations, settings, processes, relationships, systems, or people.

- *Interpretation*. They enable a researcher to (a) gain insights about the nature of a particular phenomenon, (b) develop new concepts or theoretical perspectives about the phenomenon, and/or (c) discover the problems that exist within the phenomenon.

- *Verification*. They allow a researcher to test the validity of certain assumptions, claims, theories, or generalizations within real-world contexts.

- *Evaluation*. They provide a means through which a researcher can judge the effectiveness of particular policies, practices, or innovations. (7:148)

Qualitative research studies may be performed using some common designs, that is, case studies, ethnographies, phenomenological studies, grounded theory studies, and content analyses. These types of qualitative studies are briefly presented below, summarized from Leedy (7:149-157).

- *Case Study*. A particular individual, program, or event is studied in depth for a defined period of time. They are common in medicine, education, political science, law, psychology, sociology, and anthropology.

- *Ethnography*. Different from the case study, ethnography looks in depth at an entire group that shares a common culture. The focus is on the everyday behaviors of the people in the group in order to identify cultural patterns.

- *Phenomenological Study*. It is a study that attempts to understand people's perceptions, perspectives, and understandings of a particular situation.

- *Grounded Theory Study*. Uses a prescribed set of procedures for analyzing data and constructing a theoretical model from them. Has its roots in sociology but is now used in anthropology, education, nursing, psychology, and social work.

- *Content Analysis*. It is a detailed and systematic examination of the contents of a particular body of material for the purpose of identifying patterns, themes, or biases. Typically performed over data found in human communication forms, as books, newspapers, films, television, art, music, videotapes etc.

In the attempt to define which type of design applies to a specific study is important to distinguish characteristics of the different qualitative designs. Then, a decision can be made about the most appropriate for the purpose of the study. Table 1, extracted from Leedy (7:157) shows the characteristics of each type of qualitative design.

Table 1. Distinguishing Characteristics of Different Qualitative Designs (7:157)

Design	*Purpose*	*Focus*	*Methods of Data Collection*	*Methods of Data Analysis*
Case Study	To understand one person or situation (or perhaps a very small number) in great depth	One case or few cases within its/their natural setting	Observations Interviews Appropriate written documents and/or audiovisual material	Categorization and interpretation of data in terms of common themes Synthesis into an overall portrait of the cases
Ethnography	To understand how behaviors reflect the culture of group	A specific field site in which a group of people share a common culture	Participant observations Structured or unstructured interviews with "informants" Artifact/document collection	Focus on significant events
Phenomenological study	To understand an experience from the participants point of view	A particular phenomenon as it is typically lived and perceived by humans	In depth unstructured interviews Purposeful sampling of 5-25 individuals	Search for meaning units that reflect various aspects of the experience Integration of meaning units into a typical experience
Grounded theory study	To derive a theory from data collected in a natural setting	Human actions and interactions, and how they result from and influence one another	Interviews Any other relevant data sources	Prescribed and systematic method of coding the data into categories and identifying Continual interweaving of data collection and data analysis Construction of a theory from the categories and interrelationships
Content analysis	To identify the specific characteristics of a body of material	Any verbal, visual, or behavioral form of communication	Identification and possible sampling of the specific material to be analyzed Coding of the material in terms of predetermined and precisely defined characteristics	Tabulation of the frequency of each characteristic Descriptive or inferential statistical analyses as needed to answer the research question

Surveys – Questionnaires, Interviews and Likert Scales

This section will present definitions and characteristics of a qualitative research and the relationship with this study. Then, the section will present the situations where qualitative research study may apply and its five common types. The last part will present the characteristics of surveys, related questionnaires, interviews, and finally the two techniques that allow the evaluation and quantification of peoples' perceptions; *checklist and Likert scales*.

Surveys are used in order to collect data in many areas of research. The data gathered by surveys turns into important information to those in head of organizations, either government or private owned companies.

> Surveys are used today to collect data on almost every conceivable subject, including attitudes about presidential candidates, television viewing habits or the health and well-being of the populace. (15:1)

Surveys are present on everyday business nowadays, either by questionnaires or interviews. The questionnaires are a kind of survey that can be "self-administered" and usually can be sent by mail. Interviews are another way to take surveys and usually require more time to be done – frequently named as *interview-based surveys* (15) – due to the fact that normally requires a face-to-face contact between the interviewer and the interviewed.

Also, interviews "can yield a great deal of useful information."(7:159), where the researcher can ask questions related to facts, people beliefs, feelings, motives, standards for behavior, etc. According Leedy, when interviews are applied to qualitative study they have some particular characteristics:

> The interviews in a qualitative study are rarely as structured as the interviews conducted in a quantitative study (…). Instead, they are either open-ended or semi-structured, in the latter case revolving around a few central questions. Unstructured interviews are, of course, more flexible and more likely to yield information that the researcher hadn't planned to ask for; (7:159)

Surveys are often used to learn about people's perceptions and opinions, and since behaviors and attitudes are complex and difficult to evaluate or quantify, there exist two techniques that allows the evaluation and quantification in such cases. They are *checklist* and *rating scales*. The first one is defined in Leedy as:

> A checklist is a list of behaviors, characteristics, or other entities that a research is looking for. Either the researcher of the survey participant (depending on the study) simply checks whether each item on the list is observed, present, or true; or else not observed, present, or true. (7:197)

The rating scale is a technique that allows the researcher to assign to a parameter of interest some sort of a continuum range of values that can be further quantified in numerical terms. Rating scales were first developed and reported by Rensis Likert (9) and are known as Likert scales. Leedy describe rating scales as being:

> (…) more useful when a behavior, attitude, or other phenomenon of interest needs to be evaluated on a continuum of, say, "inadequate" to "excellent," "never" to "always," or "strongly disapprove" to "strongly approve." (7:197)

Also in as reported in <u>Surveys with Confidence: A Practical Guide to Survey Research Using SPSS,</u> Likert scales are:

> (…) a ranked list of responses that runs form one to another (Strongly disagree to Strongly agree). The psychologist Rensis Likert was the first to study these scales in some depth, thus they are referred to as Likert scales. (15:15)

This section has presented the definition and characteristics of a qualitative research and the relationship with this study. Then, the section has presented the situations where qualitative research study may apply. Also, the five common types of qualitative research and their most common uses were presented. The last part has presented the characteristics of surveys, related questionnaires, interviews, and finally the two techniques that allow the evaluation and quantification of peoples' perceptions; *checklist and Likert scales*.

Projects and Risks

In the attempt to adopt SILOMS in MoD one can expect that this is going to be a challenging effort given that the activities to be performed in the attempt will be unique and unfamiliar. The outcome of such an attempt might be surrounded by uncertainties. Then, it will involve risk of failure in this effort concerning the feasibility and the results associated in case of the outcome do not be the expected by the MoD users. The existences of such characteristics are some of those that define an activity as a project. A project management approach will, likely, be the preferred choice to handle the implementation of SILOMS in the MoD. Then, a literature review about project's characteristics and management, as well as the inherent risks involved is justified. These concepts will help in the definition of the method used to assess the feasibility of using SILOMS in the MoD.

Projects and Project Management Approach

In the attempt to accomplish a goal, an organization may face unique circumstances surrounding the tasks to be performed. The familiarity with the tasks and the acknowledgement

of the processes to be performed in addition to well defined statement and requirements of the end-item or product constitute key features that will define the success of the activity. Such activities with certain characteristics can be called as project. In A Guide to Project Management Body of Knowledge, reported by Nicholas in (10:4), project is defined as:

> A project can thus be defined in terms of its distinctive characteristics – a project is a temporary endeavor undertaken to create a unique product or service. (10:4)

According John M. Nicholas in *Project Management for Business and Technology*, some characteristics can be used to warrant classifying an activity as a project:

- A project involves a single, definable *purpose*, *end-item*, or *result*, usually specified in terms or cost, schedule, and performance requirements.

- Every project is *unique* in that it requires doing something different than was done previously. Even in "routine" projects such as home construction, variables such as terrain, access, zoning laws, labor market, public services, and local utilities make each project different. A project is a one-time activity, never to be exactly repeated again.

- Projects are *temporary* activities. And ad hoc organization of personnel, material, and facilities is assembled to accomplish a goal, usually within a scheduled time frame; once the goal is achieved, the organization is disbanded or reconfigured to begin the work on a new goal.

- Projects *cut across organizational lines* because they need the skills and talents from multiple professions and organizations. Project complexity often arises form the complexity of advanced technology, which creates task interdependencies that may introduce new and unique problems.

- Given that a project differs from what was previously done, it also involves *unfamiliarity*. It may encompass new technology and, for the organization undertaken the project, posses significant elements of *uncertainty* and *risk*.

- The organization usually has something at stake when doing a project. The activity may call for special scrutiny or effort because of failure would jeopardize the organization or its goals.

- Finally, a project is the *process* of working to achieve a goal; during the process, projects pass through several distinct phases, called the *project life cycle*. The tasks, people, organizations, and other resources change as the project moves from one phase to the next. The organization structure and resource expenditures slowly build with each succeeding phase; peak; and then decline as the project nears completion. (10:4)

The above characteristics when found in an activity may lead to the adoption of a particular approach of management called project management as defined in A Guide to Project Management Body of Knowledge, reported by Nicholas:

> Project Management is the application of knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project. (10:4)

Some key characteristics of project management are summarized from Nicholas (10:22-23):

- One person – the project manager – heads the project organization
- Project manager unifies all efforts to achieve project objectives
- Several functional areas often perform the work
- Project manager is responsible for integrating the efforts of the functional areas working on the project
- Project manager negotiates directly with functional managers for support
- Project focuses on delivering a particular product or service at a certain time and cost and to the satisfaction of technical requirement.

The program manager has the key role of seeing the "big picture" or taking a system approach to the project to assure that each task being performed is in accordance to the main goal in the project. Ultimately he is the responsible to minimize the inherent risks involved in

projects by quantifying them and by taking appropriate measures to avoid or minimize their impacts in the project goal. The successful project management relies upon the need to accomplish the called "triple constraint":

> Every project is constrained in different ways by its scope, time, and costs goals – the Triple Constraint. (…) Successful project management means meeting all three goals – and satisfying the project sponsor. (10:20)

Project and Inherent Risks

In the attempt to accomplish a project goal, the project manager has to assess the risks involved in the most difficult tasks or those surrounded by unfamiliarity. The assessment and a measure of the risk involved in projects is a practice that has to be used before starting a project. One organization may decide if it is worthy to take the risk involved in a specific project only if the organization can measure the risk and the consequences of doing or not doing the project.

When an organization is developing a computer-based information system or even trying to adopt an existing one, the characteristics of the activities and tasks to be performed may fit all those described to define a project. Software and database development normally is unique efforts to meet specific needs of organizations; involves many sectors or "cut across the organizational lines" and is surrounded by unfamiliarity, uncertainty and possess significant elements of risks.

In this section we've seen the concepts of projects as well as project management approach and the inherent risks involved in such kind of activities. The adoption of SILOMS in the MoD can be seen as an activity that has all to do with a project and project management

practices and this allows the study to apply some of the project concepts to assess risks and then help the decision makers to decide whether or not is feasible to adopt SILOMS in the MoD.

Managing Risks and Software Project Risk Analysis Methods

This section will present the concepts of managing risks related to projects and their relation with this study. Also, a brief discussion about risk analysis methods will be presented.

In general risks arises when there exist uncertainties, which in turn is related with unfamiliarity or uniqueness of an activity or project. The experience of the project team also counts on the possible risks involved. When both conditions exist, uniqueness and inexperienced team, the outcomes of a project becomes more uncertain making it difficult to know what could go wrong and how to avoid problems since the outcomes can be influenced by factors that are new, emerging, or beyond manager's control. Stated by Nicholas:

> Every project is risky, meaning there is a chance things won't turn out exactly as planned. Project outcomes are determined by many things, some that are unpredictable and over which project managers has little control. (10:336)

The notion of project risk involves the concepts of the likelihood that some problematical event will occur and the impact if the event does occur. And Nicholas stated it as a join function in the following formulation "Risk = f(likelihood, impact)" (10:307).

No matter if only one exists, that is, either the likelihood or the impact, the project may be considered risky whenever some particular outcomes have the probability of existing, such as human casualties or huge material losses. According Nicholas:

> One project will be considered risky where the potential impact is human fatality or massive financial loss even when the likelihood of either is small. (10:307)

The risk involved in the case of engaging in a project to use SILOMS in the MoD might/may not be fatal, but certainly will involve financial losses if the outcome is not the expected one. Also, depending on the circumstances, the MoD may incur in a high risk of not having such a system to support a quick response to the logistical support requirements in the case of the raise of a conflict. In that case, the fatalities may occur due to the fact that a good information system could better help the logistics support for a conflict.

Risks are inherent to projects and the consequences of failures may be disastrous depending to the circumstances. Before accepting the risk of engaging in a project, the decision makers have to be able to measure it, and then, decide if it is worth to take it.

A risk analysis related to software development projects can be defined as the evaluation of the risk potentials associated with the development process and also those risks associated with the tools, methods and approaches to be used during the software project development. The inadequate software project risk analysis is associated with many factors and may cause the failure of a project. Jones defines "Inadequate Software Project Risk Analysis" as:

> A) Failure to consider or properly evaluate the risk potential of significant software projects prior to commencement;
>
> B) Failure to consider or properly evaluate the risk potentials of significant software projects based on changes after development begins;
>
> C) Failure to consider risks associated with tools, methods, and approaches prior to acquisition and deployment. (6:254)

Jones (6) considers the roots of inadequate risk analysis due to the fact that risk analysis is taught neither by software engineering curricula nor by enterprise training curricula. Also he highlights the fact that "serious risk analysis is a fairly recent phenomenon" (6:255) and that due to corporate culture of the enterprises, they tends to ignore risk-related conditions.

This section presented the concepts of managing risks related to projects as well as the relation of this concept with this study. Also, a brief discussion about risk analysis methods has been presented.

Taxonomy-Based Risk Identification Method

This subsection will present the Taxonomy-Based Risk Identification Method (TRI), proposed by a report of the Software Engineering Institute (SEI) of the Carnegie-Melon University, for software development activities. Also, this section will highlight the importance of this taxonomy related to this study.

As seen in the last section, the implementation of SILOMS in the MoD can fit the definition of a project and the decision of whether or not to proceed with the implementation may rely upon the risk assessment and identification of such activity. In most organizations and business administration when decision makers are deciding about an investment or implementation of a new service or activity they have to make sure that such initiative will have a reasonable chance of success. Beside other considerations, as resources available, and firm's strategy, they have to assess the risks involved in the activity in order to decide whether is worthy to start the activity or whether is better to consider another alternatives to the particular/identified need. As Perry states in "Effective Methods for Software Testing":

> Risk is the probability that undesirable events will occur. These undesirable events will prevent the organization from successfully implementing its business initiatives. For example, there is the risk that the information used in making business decisions will be incorrect or late. If the risk turns into reality and the information is late or incorrect, an erroneous business decision may cause a failed business initiative. (11:7)

According to the risks involved the activity may or may not be implemented and the result of such decision may be crucial for the organization's future performance. Then, it is important to know how to identify risks according to a methodology that assures that key factors are being considered in the risk assessment. The risk identification helps to better understand what can jeopardize the project by allowing the adoption of measures that can attenuate its effects or simple by avoiding the risks.

The Software Engineering Institute (SEI) of Carnegie- Mellon University has developed a risk identification method used to assess risks in software development. The SEI taxonomy of software development maps the characteristics of this type of activity and the consequent software development risks. In the particular situation of software development project, according Carr J., in <u>Taxonomy-Base Risk Identification</u> (1) the risks:

> (…) can be known, unknown, or unknowable. Known risks are those that one or more project personnel are aware or – if not explicitly as risks. At least as concerns. The unknown risks are those that would be surfaced (i.e., become known) if project personnel were given the right opportunity, cues, and information. The unknowable risks are those that, even in principle, none could foresee. Hence these risks, while potentially critical to project success, are beyond the purview of any risk identification method. (1:7)

This concepts and the use of such taxonomy relates to this study in the sense that the use of this methodology can be useful in the assessment of the risks involved in the implementation of SILOMS in the MoD.

This subsection has presented the Taxonomy-Based Risk Identification Method, proposed by a report of the Software Engineering Institute (SEI) of the Carnegie-Melon University, for software development activities and highlighted the importance of this taxonomy related to this study.

Taxonomy Based Questionnaire for Software Development

This subsection will present the Taxonomy-Based Questionnaire derived from the Taxonomy-Risk Identification Method presented in the last section. Also, this section will highlight the importance of semi-structured interviews while yielding a more valid data in risk assessment for software development.

The Taxonomy-Based Identification Risks is a repeatable method for identifying risk in software projects using a software risk taxonomy and associated questionnaire. It uses basically a Taxonomy-Based Questionnaire (TBQ), which consists of a list of non-judgmental questions to elicit issues and concerns and the related risks in each taxonomic group – Appendix C has a example of a TBQ. The use of the questionnaire guarantees that all identified risks are taken in account:

> (…) the questionnaire ensures that all risk areas are systematically addressed, while the application process is designed to ensure that the questions are asked of the right people and in the right manner to produce optimum results . (1:7)

The TBQ application is semi-structured and the questions are used as a defining but not as a limiting instrument in the way that allows the discussion to be made without concerns with the already given sequence of questions. The non-restriction of the sequence permits the assessment of more subjective issues as in a structured brainstorming process. Yet, it yields more valid data according Suchman in "Interactional Troubles in Face-to-Face Survey Interviews" reported by Marvin J. Carr in Taxonomy-Based Risk Identification:

> This is done (no-restriction of sequence) to permit context-and-culture-sensitive issues to arise in as "natural" a manner as possible. A completely structured interview, while arguably yielding more reliable data for subsequent analysis across different projects, may also yield less valid data. (1:8)

In order to provide a framework to the application of the risk identification method is fundamental the understanding of the software development taxonomy developed by SEI. The software development taxonomy:

> (…) serves as the basis for eliciting and organizing the full breadth of software development risks – both technical and non-technical. The taxonomy also provides a consistent framework for the development of other risk management methods and activities. (1:08)

The software taxonomy is organized into three major classes (a three level taxonomy), that is, product engineering, development environment and program constraints. The three major classes then are divided into elements, which in turn are characterized by their attributes.

Table 2. Complete 3-level SEI Software Development Risk Taxonomy

A. Product Engineering	B. Development Environment	C. Program Constraints
1. Requirements	1. Development Process	1. Resources
a. Stability	a. Formality	a. Schedule
b. Completeness	b. Suitability	b. Staff
c. Clarity	c. Process Control	c. Budget
d. Validity	d. Familiarity	d. Facilities
e. Feasibility	e. Product Control	2. Contract
f. Precedent	2. Development System	a. Type of Contract
g. Scale	a. Capacity	b. Restrictions
2. Design	b. Suitability	c. Dependencies
a. Functionality	c. Usability	3. Program Interfaces
b. Difficulty	d. Familiarity	a. Customer
c. Interfaces	e. Reliability	b. Associate
d. Performance	f. System Support	Contractors
e. Testability	e. Deliverability	c. Subcontractors
f. Hardware Constraints	3. Management Process	d. Prime Contractor
g. Non-Developmental	a. Planning	e. Corporate
Software	b. Project Organization	Management
3. Code and Unit Test	c. Management	f. Vendors
a. Feasibility	Experience	g. Politics
b. Testing	d. Program Interfaces	
c. Coding/Implementation	4. Management Methods	
4. Integration and Test	a. Monitoring	
a. Environment	b. Personnel	
b. Product	Management	
c. System	c. Quality Assurance	
5. Engineering Specialties	d. Configuration	
a. Maintainability	Management	
b. Reliability	5. Work Environment	
c. Safety	a. Quality Attitude	
d. Security	b. Cooperation	
e. Human Factors	c. Communication	
f. Specifications	d. Morale	

Carr, as follow, describes the definition of each class.

1. Product Engineering. The technical aspects of the work to be accomplished.

2. Development Environment. The methods, procedures, and tools used to produce the product.

3. Program Constraints. The contractual, organizational, and operational factors within which the software is developed but which are generally outside of the direct control of the local management. (1:8)

The complete SEI Software Development Risk Taxonomy is presented in Table 2 and a summary of Software Development Risk Taxonomy is represented in Figure 5.

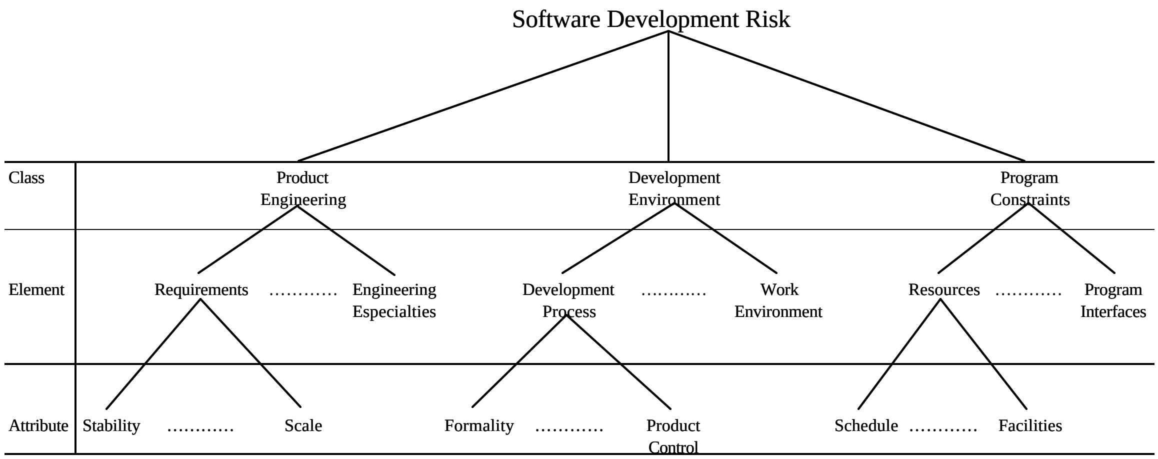

Figure 5. Software Development Risk Taxonomy (1:9)

This subsection has presented the Taxonomy-Based Risk Identification Method, its derived Taxonomy-Based Questionnaire for software development activities and the relation with this study. Also it has highlighted the importance of semi-structured interviews while yielding a more valid data in risk assessment for software development.

Project Force Field Analysis

This subsection describes the method named as “Force Field Analysis” proposed by Kurt Lewin in <u>Field Theory Analysis</u> (8).

Lewin (8) has proposed a method for analyzing problem situations and determining alternative courses of action by organizing information pertaining to organizational improvements into two categories: those “forces” at work that restrain improvement, and those that facilitate

it. In the theory, he states that the state of affairs of any situation is allowed to persist due to the fact that restraining and facilitating forces are in equilibrium. In the case of restraining of forces occur to increase, then the state of affairs will worsen. On the other hand, in the case of facilitating forces are strengthened the state of affairs will improve - Figure 6.

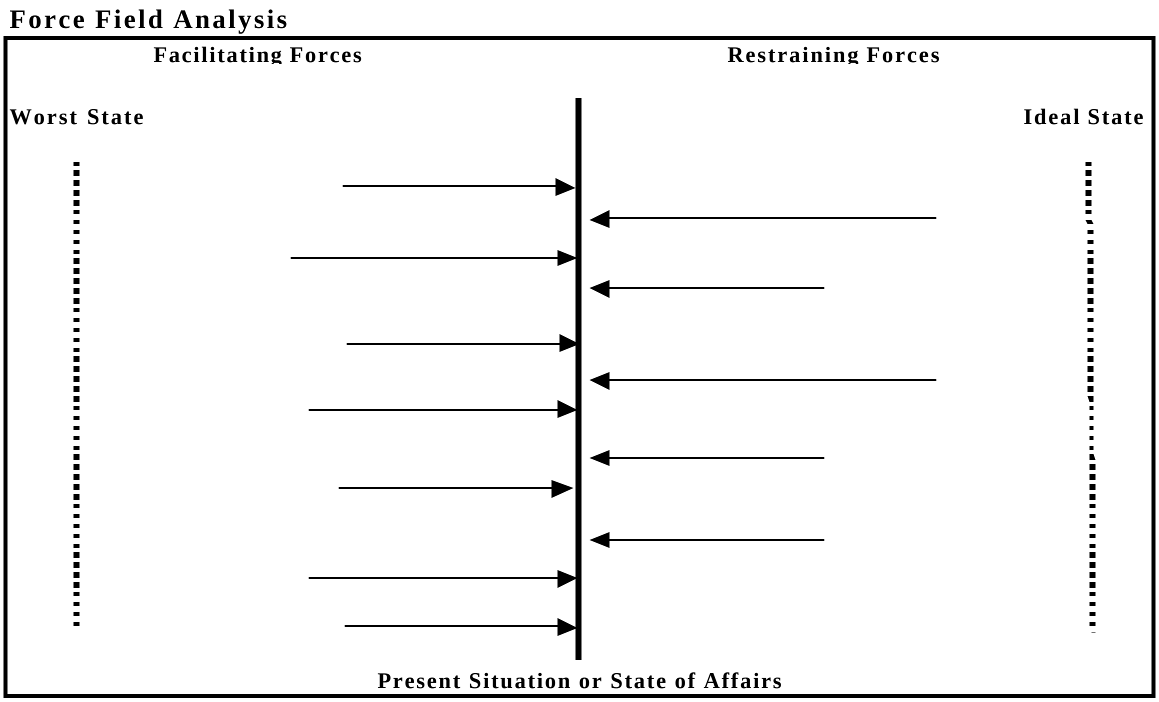

Figure 6. Force Field Analysis. Extracted from (10:548)

The “Force Field Analysis” uses a dichotomy of forces to determine the best way to improve a given situation by identifying all of the restraining and facilitating forces and the relative strength of each. Then, according the theory is possible to determine which restraining forces must be weakened or which facilitating forces must be strengthened to move the situation toward the ideal state. The technique was originally proposed as a means for overcoming resistance to change, but as states Nicholas:

(…) it can be used by managers in other applications. In project management, the technique can be used to investigate forces acting on a current project or that might influence an upcoming project, and to determine where emphasis is needed to increase the project's likelihood for success. (10:548-549)

Some important considerations have to be made by observing Figure 6. First of all, the forces acting in the system are potentially either facilitating or restraining, meaning that an specific factor may be considered a restraining force when it is lacking but may be considered facilitating force when it is present. Also, when there is a weak or no presence of a force related to that factor, then, it becomes a restraining force leading to the "worst state". However, if the force related to that factor is present, its facilitating influence depends on its strength and visibility. Second, not all forces related to factors are equal; some are of generally greater importance and influence than others. Finally, the forces are not always independent in the sense that improving or strengthening some facilitating forces may have a ripple effect on other facilitating forces. The implementation of the analysis is described in Nicholas as follows:

> A force field analysis can be used in particular cases for determining which forces might hinder a new project, or for analyzing the forces acting on a current project. The value of the technique, even if not strictly followed, is that it systematizes thinking and organizes information about project problems and causes. The analysis begins by gathering information through questionnaires or interviews about the forces facilitating and hindering the project performance. (…) The forces then are ranked so that the strongest are given highest priority. (10:550)

The implementation involves other steps, like rating the forces according their "solvability", and then generating actions for reducing the "solvable" restraining forces with the highest priority, which was given in the previous steps. Nicholas states that:

> The utility of the force field analysis process is the systematic framework it provides for viewing problems and identifying solutions with the highest likelihood of success. (10:550)

In the implementation of SILOMS in the MoD, the identification of facilitating and restraining forces can help to built a framework to provide the solutions of even to make possible the assessment of the risks involved in such activity.

This subsection has presented the method *Force Field Analysis* as a possible technique to be used in the assessment of risks in SILOMS's implementation in the MoD.

Software Engineering Risk Model –SERIM

This subsection describes the Software Engineering Risk Model (SERIM) described by Karolak in Software Engineering Risk Management (6). This model will be described as a way to implement the Taxonomy-Based Risk Identification Method (TRI) – a software risk identification method.

Choices exist when making decisions concerning risks on software projects. These choices have to be evaluated in a way to help the decision makers to assess alternatives available in a given scenario. According Karolak(6:121):

- The firsts step is to analyze alternatives – Alternatives must exist when deciding activities based on risks.
- The second step is to create a model which will evaluate alternatives. The model should help in the decision making process by assessing the alternatives.
- The third step is to make a choice. If a choice is not made, the passing of time will dictate the choices for you.

The Software Engineering Risk Model is based on a premise that software development management alternatives are always present. SERIM uses the form of a probability tree addressing decisions alternatives and the use of probabilities. The model uses the mathematics of probability and uses it concepts to address the likelihood that an occurrence of event A lies within the sample space S, where S is the list of all possible outcomes of events. Normal rules of probability hold (6:121-122):

a) P(A) is the probability of event A,

b) $0 \leq P(A) \leq 1$,

c) P(S) = 1, P (0) = 0,

d) If A1, A2, … An is a sequence of mutually exclusive events, then
$P(A1 \cup A2 \cup \ldots \cup An) = P(A1) + P(A2) + \ldots P(An)$

SERIM uses a subjective Bayesian probability approach to assess software risks. This approach assigns a subjective probability based on previous experience or analogy to past events, that is, a personal view measuring the likelihood or reasonableness that event A will occur. It is interesting to note that if more than one person assesses the subjective probability, then, different results may be expected. As stated by Karolak:

> For two events, A and B, P(A) is greater than or equal to P(B) if and only if A was considered to be more likely than B. In this approach, probability is a measure of the belief one has in the occurrence of and event. For SERIM, the assignment of numeric values to software risk metric questions shared this same subjectivity in the sense that different persons may end up with different values based on their past and diverse experiences, business products, and software development environments for what they are assessing. As such, the probability assigned to an event need not to be a constant value but can change based on additional experience. (6:121)

The numeric values used in SERIM are set by the responses to the metric questions (according to the taxonomy of risk identification adopted) defined to perform the interviews. Based on the responses to the questions having a value between 0 and 1, the probability of risks can be computed. Then, probability trees are used to calculate an overall success rate, which is a weighted average of the probability of events associated with the risk.

SERIM relates risk metrics to software life cycle phases and software risk management activities. By doing so, software risk can be identified by the phase of the software development and correlated to each of the metric questions used in the risk identification method.

> Likewise, the probability for each life cycle phase, risk factors, risk elements, and risk management activities can be represented as a probability tree based on the answer to the metric questions. (6:123)

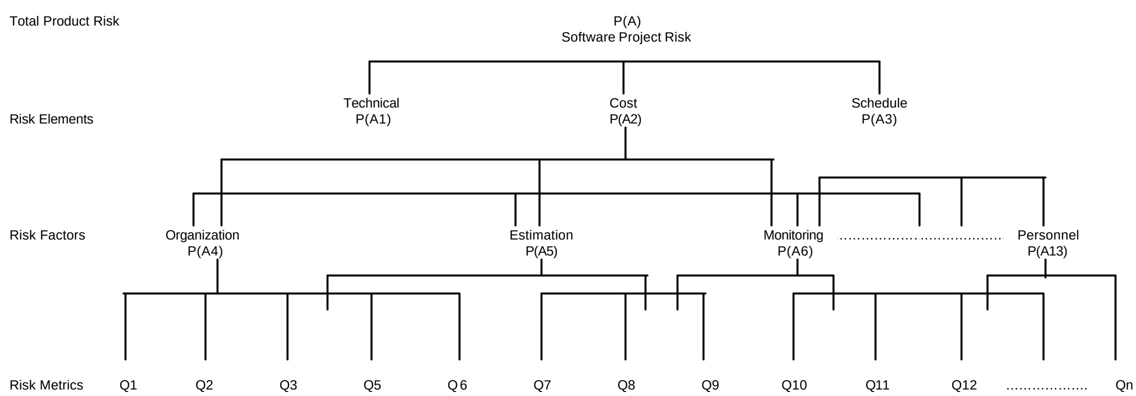

Figure 7. Partial Software Risks Relationships from Karolak (6:124)

The example used in Karolak (6:121-131), and partially reproduced in Figure 7, shows the relationships within risk's parameters and Table 3 and Table 4 shows the detailed risks' parameters, where:

- P(A) represents the probability of a successful software project,

- P(A1), P(A2), and P(A3) identify the likelihood of successfully meeting future technical, cost, and schedule goals.

- P(A4) through P(A14) represent the likelihood of successfully meeting the software risk factors identified according a given methodology or risk identification.

- P(B) through P(G) represent the likelihood of a successful software project based on the phase the software development life cycle of the project.

- P(H) through P(M) identify the probability of meeting the software risk management activities previously identified.

To implement SERIM, several parameters and equations must be identified and considered. The following equations are used for each of the probability trees according the example given by Karolak (6:121-131):

1) $P(A) = [\Sigma^{3}_{n=1} P(An)]/3$ assuming that each risk element is equal in weight. If the weight of each element differs between them, then $P(A) = w_1P(A_1) = w_2P(A_2) + w_3P(A_3)$ where each w_i is a positive number and $w_1 + w_2 + w_3 = 1$.

2) $P(Element) = [\Sigma^{13}_{n=4} w_nP(An)]$ where:

    a. An is the metric value for the factors identified in Table 3, and related to the element being measured

    b. w_n is the weight assigned according risk factor's influence against risk elements.

3) $P(Factor) = [\Sigma^{q}_{n=1} P(Qn)]/8$ where Qn is the metric value for the question number Qn identified as related to the factor being measured.

4) P(Development Phase) = Σ(All values assigned to the questions related to the developmental phase)/number of questions.

5) P(Software Management Activity) = Σ(All values assigned to the questions related to the software management activity)/number of questions.

Table 3. Sw Risks According the Example Extracted from (6:121-131)

Software Risk Elements	
A1	Technical
A2	Cost
A3	Schedule
Software Risk Factors	
A4	Organization
A5	Estimation
A6	Monitoring
A7	Development Methodology
A8	Tools
A9	Risk Culture
A10	Usability
A11	Correctness
A12	Reliability
A13	Personnel

Table 4. Sw Development Phases and Risk Management Activities – (18)

Project's Software Developmental Life Cycle - Phases	
B	Pre-Requirement
C	Requirements
D	Design
E	Code
F	Test
G	Development and Maintenance
Software Risk Management Activities	
H	Identification
I	Strategy and Planning
J	Assessment
K	Mitigation/Avoidance
L	Reporting
M	Prediction

By adding SERIM to TRI, both turns into a software risk identification method supported by a tool that makes possible the consolidation of the software risk information gathered by the use of the TBQ. SERIM will tie the relationships between all the software risk information available in order to help the decision makers in addressing decisions alternatives through probabilities.

This subsection has described SERIM as a way to implement the Taxonomy-Based Risk Identification Method (TRI) – a software risk identification method.

Chapter Summary

This chapter has presented the definitions and characteristics of a qualitative research as well as considerations about surveys and the use of questionnaires, interviews and Likert's scale and its application to the present study. Second, a literature review of the relationship between projects and risks, as well as the appropriateness of using project management approach in activities with inherent risks associated were discussed. Third, the chapter discussed and presented the concepts of managing risks in software development project and available risk analysis methods. Fourth, the "Taxonomy-Based Risk Identification", a method to risk identification in software development environments, and the derived Taxonomy-Based Questionnaire (TBQ) were presented. Fifth, *Force Field Analysis* was presented as a technique available for analyzing problem situations. Finally the SERIM model was presented as a way to implement the TRI.

III. Methodology

Introduction

This chapter describes the procedures taken during the research process to achieve its objectives. Describing the research design, and data analysis method, the chapter will end up in proposing a method to answer the *Investigative Questions* stated in Chapter 1 and consequently, also end up by providing means to answer the *Research Question.*

In order to accomplish this goal, first, this chapter will present the research design and data analysis method, that is, a combination of a qualitative and quantitative methods using a mix and adapted tools described in Chapter II, to gather and analyze the data obtained in the research process. The first section is subdivided into two subsections describing the methodology used in each qualitative and quantitative portions of this study. Second, this chapter will present the population involved in the study as well as the sampling information, which consists of a few carefully selected agencies in the MoD. Third, this chapter describes the nature of the data involved in the study. Finally a brief summary will be presented.

Research Design and Data Analysis

This section describes the research design chosen to perform this study, a combination of qualitative and quantitative analysis of the organizational, cultural and political aspects that can threat the successful implementation of SILOMS in the MoD's agency SELOM. It also describes the data analysis method used to assess the risk associated with this implementation.

As shown in the literature review in Chapter II, qualitative methods have the advantage of going in depth in the problem by allowing more flexibility to the researcher in a real world environment or natural setting with inherent subjective aspects. Also, qualitative research is more adequate to explore human events that have inherent subjectivism and where multiple perspectives can be held by different individuals. These multiple perspective, in turn, may have equal validity or add value to the data analysis and conclusions. Furthermore, these multiple perspectives and revealing their natures end up of being one important goal of qualitative studies.

The qualitative portion of this study will be performed using a combination of two of the five common designs to qualitative studies, described in Chapter II, that is, Case Study, Ethnography, Phenomenological Study, Grounded Theory Study or Content Analysis. The chosen design is a combination of *Case Study* and *Phenomenological Study*. The first one is described in Leedy as:

> In a case study, a particular individual, program, or event is studied in depth for a defined period of time. (…) A case study may be especially suitable for learning more about a little known or poorly understood situation. It may also be useful for investigating how an individual or program changes over time, perhaps as the result of certain circumstances or interventions. (…) The researcher also records details about the context in which the case is found, including information about the physical environment and any historical, economic, and social factors that have bearing on the situation. (7:149)

The second one is described in Leedy as:

> In its broadest sense, the term phenomenology refers to a person's perception of the meaning of an event, as opposed to the event as it exists external to the person. A Phenomenological study is a study that attempts to understand people's perceptions, perspectives, and understandings of a particular situation. (7:153)

The combination of *Case Study* and *Phenomenological Study* were chosen because these designs seems to be complement each other and this mix is more appropriate to fit the research objective of understanding the risk associated to organizational, cultural and political aspects that can threat the successful implementation of SILOMS in the MoD's agency SELOM. Furthermore, it is important to gather people's perceptions about the implementation of SILOMS and look for hints and issues that can be viewed as a threat to a successful implementation. This kind of design has interesting characteristics as pointed out by Leedy:

> The actual implementation of a phenomenological study is as much in the hands of the participants as in the hands of the researcher. The phenomenological interview is often a very unstructured one in which the researcher and the participants work together to "arrive at the heart of the matter" (Tesch, 1994, p. 147). The researcher listens closely as participant describe their everyday experiences related to the phenomenon and must be alert for subtle yet meaningful cues in participants' expressions, questions, and occasional sidetracks. A typical interview looks more like an informal conversation, with the participant doing most of the talking and the researcher doing most of the listening. (7:153)

On the other hand, a qualitative assessment only may be not sufficient to give an objective evaluation of the risks involved in the implementation of SILOMS in the MoD. A quantitative analysis applies to this case in the way that it is necessary to quantify the risks involved in the implementation of SILOMS in the MoD by assigning probabilities for the identified risks. The assignment of probabilities may come from different basis, like experimental evidence, expert opinion, subjective judgment. In any case the value added to data analysis is worthy. Furthermore, when probabilities are assigned, some sort of a

quantitative analysis is needed either to allow further comparisons among available alternatives or either by simple measuring the probability of success or failure of a unique situation.

This study has relied upon an adaptation of the Taxonomy-Based Identification Risk Method (TRI), and derived Taxonomy-Based Questionnaire (TBQ) proposed by Carr in Taxonomy-Based Risk Identification (1), to undertake interviews with key personnel in SELOM, the MoD's agency. The questionnaire used in the interviews was designed mainly to gather qualitative and quantitative data and achieve two goals:

- Gather data concerning peoples' perceptions about issues related to risks in software development projects, through the use of open-ended questions.
- Gather data related to the risks factors, attributes and elements, under the adapted taxonomy or risk identification, through the use of objective or standard questions.

The methods used to gather and analyze both qualitative and quantitative data will be described separately in the next subsections. First, the methodology used to gather and analyze the qualitative portion will be presented. Second, there will be a presentation about the way the qualitative assessment turns into a quantitative measure to provide an objective assessment of the feasibility of SILOMS's implementation in the MoD.

Qualitative Design Portion Methodology

In order to perform the qualitative portion of this research, this study has relied upon an a adaptation of the Taxonomy-Based Risk Identification Method (TRI) and its derived Taxonomy-Base Questionnaire (TBQ) proposed by Carr in Taxonomy-Based Risk Identification(1). The TRI method and the TBQ had been used as a basis to the development

of the MoD-SILOMS Taxonomy Risk Identification Method (MSTRI) – Figure 8 - and its derived SILOMS Taxonomy-Based Questionnaire (MSTBQ) – see Appendix A.

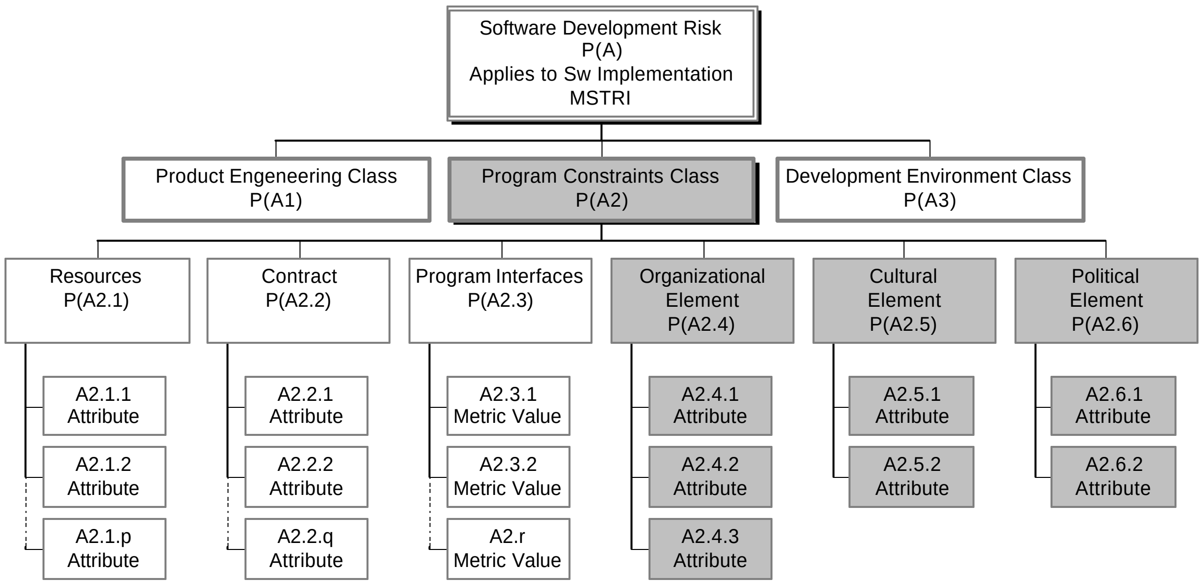

Figure 8. MSTRI - Taxonomy Adapted from Carr (1)

The MSTRI is a taxonomy adapted to fit the special case considered in this study, that is, the implementation of SILOMS in the MoD. The derived MSTBQ is a semi-structured interview based on a mix of open-ended and objective or standard questions. The researcher has performed the interviews with key personnel in pre-selected MoD's agencies – see Figure 11. The interviews had the objective of gathering data concerning parameters, such as the proposed risk factors, attributes and elements, according to MSTRI. These parameters were selected according to the researcher's experience on the field, observations and also in expert opinions found in the literature, by being common problems/issues, which may have potential

effects over a software development project such as the implementation of SILOMS in the MoD.

Questionnaire

The MSTBQ used to perform the interviews has five sections; the first section consists of an explanation to the interviewees about the SILOMS project. The second section consists of an explanation of the context and purpose of the research. The third section's questions relate to demographic data. The fourth section explains the scoring method for the objective or standard questions consisting of the use of a rating scale and a rank order procedure which are basically the use of Likert scales and the assignment of weights - given by interviewees - according to the relative importance of the parameter compared to others. The fifth and last section contains the definitions of the *Program Constraints Class* defined under the MSTRI and the questions within MSTBQ, which is the main source of data in this research, as will be described in further section in this Chapter.

The open-ended questions were used to assess the interviewee's subjective opinions and perceptions to specific issues related to software development knowledge and about SILOMS. This kind of questions helped the researcher to gather information and draw conclusions that would not be possible in either objective or standard questions.

In addition, objective or standard questions were used to gather more specific opinions in a way that they could be assigned numerical measures values, according to the rating scale, to further help the data analysis. These objective or standard questions were the parameters in which the quantitative portion of the research was performed.

Since the MSTRI is a taxonomy that depicts factors, attributes and elements that can turn into risks or constraints to the implementation of SILOMS in the MoD, then in this point, we can say that the MSTRI and its derived MSTBQ is a tool used in the research to answer the *Investigative Question*:

- What are the factors critical to the successful implementation of SILOMS in the MoD?

The remaining investigative questions will be answered by the use of a methodology described in the following section.

Quantitative Design Portion Methodology

This study relied upon the MSTBQ to gather quantitative data through the use of objective and standard questions related to the risks factors, attributes, and elements under the *Program Constraints Class*, defined in the MSTRI and shown in Figure 10.

A quantitative analysis applies to this case in the way that it is necessary to quantify the risks involved in the implementation of SILOMS in the MoD by assigning probabilities for the identified risks. The assignment of probabilities may come from different basis, like experimental evidence, expert opinion, subjective judgment. Once probabilities were assigned, quantitative analysis is needed either to allow further comparisons among available alternatives or by simple measuring the probability of success or failure of a unique situation.

In the particular case of this study, the probabilities were assigned to the objective or standard questions - described in the last section as parameters - within the MSTBQ. These represented risk factors, attributes and elements related to the MSTRI. Each attribute was

translated into questions in the interview form of the MSTBQ - see Appendix A. Then a rating scale was used to assign numbers, within a range of values, based on a general scale shown in Figure 9.

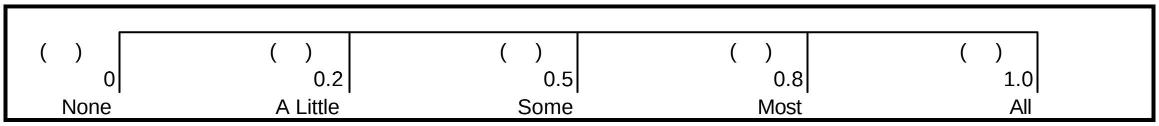

Figure 9. Scale as a general reference

These values of probabilities were assigned using a subjective judgment of the researcher and interviewees, as well as expert opinions found in the literature. The subjective judgment was then, translated into probability. As states Fabriky:

> Decision making under risk occurs when the decision maker does not suppress acknowledged ignorance about the future, but makes it explicit through the assignment of probabilities. Such probabilities may be based on experimental evidence, expert opinion, subjective judgment, or a combination of these. (3:102)

The objective or standard questions were designed to measure software risk *factors* that are designated to *attributes*, which in turn are associated to *elements*, and finally linked to the *Program Constraints Class*. Therefore, the numbers associated to the factors were used as a way to quantify risk associated with each aforementioned parameter within the MSTRI taxonomy risk identification.

Using concepts of the Software Engineering Risk Model (SERIM) proposed by Karolak in <u>Software Engineering Risk Management</u> (6) - described in Chapter II – the numbers assigned were used to implement the risk assessment of the *Program Constraint Class* considering the hierarchy and relationships within the risk factors, attribute and elements under

the MSTRI – see Figure 10. Then the consolidation of the probabilities assigned to the parameters ended up by being a number, which represents the probability of a successful implementation of MSTRI's *Program Constraint Class*. Ultimately the number assigned to the *Program Constraint Class*, within the defined scope of this research, ends up by being the probability of successful implementation of SILOMS in the MoD.

The hierarchy, relationship and interdependencies within the risk factors, attributes and elements that were used to assess the risks involved in the *Program Constraints Class* is shown in Figure 10.

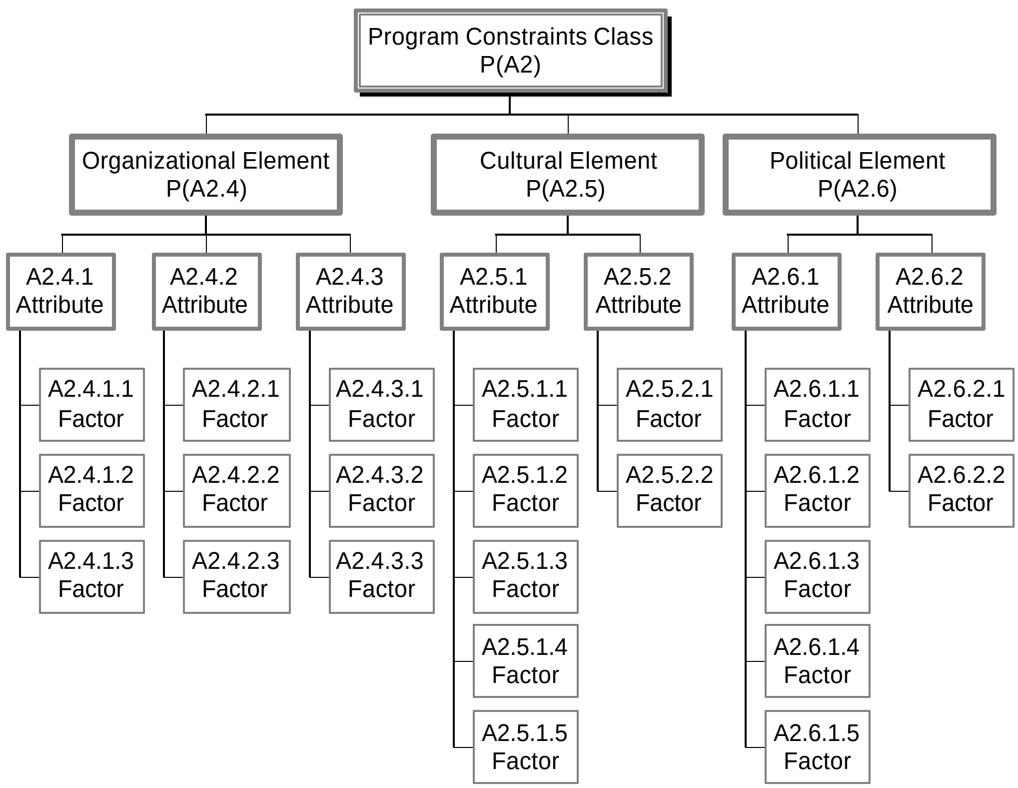

Figure 10. Program Constraint Class - Parameters' Relationship – MSTRI.

Table 5. Detailed List of Parameters' Hierarchy

	Program Constraints Class	
Element	**A2.4 - Organizational Element Risk**	
Attribute	A2.4.1 - Differences in Organizations' Structures	
Factor		A2.4.1.1
Factor		A2.4.1.2
Factor		A2.4.1.3
Attribute	A2.4.2 - Managers Commitment to Cross Organizational Projects	
Factor		A2.4.2.1
Factor		A2.4.2.2
Factor		A2.4.2.3
Attribute	A2.4.3 - Organization's Strategy to Cross-Organization Project Management	
Factor		A2.4.3.1
Factor		A2.4.3.2
Element	**A2.5 - Cultural Element Risk**	
Attribute	A2.5.1 - Differences in Organizations' Cultures	
Factor		A2.5.1.1
Factor		A2.5.1.2
Factor		A2.5.1.3
Attribute	A2.5.2 - Willingness to Change	
Factor		A2.5.2.1
Factor		A2.5.2.2
Element	**A2.6 - Political Element Risk**	
Attribute	A2.6.1 - Internal Disputes in Organizations' Politics	
Factor		A2.6.1.1
Factor		A2.6.1.2
Factor		A2.6.1.3
Factor		A2.6.1.4
Factor		A2.6.1.5
Attribute	A2.6.2 - Feuds Existence in Organizations' Politics	
Factor		A2.6.2.1
Factor		A2.6.2.2

Another issue that was taken into account in the interviews when performing the fifth section of the MSTBQ was that the researcher asked for the interviewees to rank order the attributes, within each element, and the elements, within the *Program Constraints Class*. This was done to allow the assignment of weights to risk factors, attributes and elements to reveal the

importance, according the interviewees' perception, of the parameters in the computation of the total risk assessment.

Finally, the SERIM method is, in conjunction with the MSTRI and MSTBQ, the tool used in the research to quantify the risks factors, attributes and elements that can turn into a potential risks or constraints to the implementation of SILOMS in the MoD. Furthermore, these combined methodologies will be used in the research to answer investigative questions stated in Chapter 1.

This section has described the design and data analysis method used to analyze the data gathered from researcher's observation as well as from parameters, within the MSTRI, assessed in the interviews. Also it has described the way in which the qualitative data has provided a quantitative assessment, through the assignment of probabilities, in those parameters that represented the occurrence of a particular risk. And finally this section has presented the parameters' hierarchy, relationship and interdependencies, which ended up with a number that gives an objective assessment of the probability of successful implementation of SILOMS in the MoD.

Summary of Steps Taken in the Research Process

This subsection summarizes all the steps taken to perform this study. After the description of the design and data analysis made in the previous subsections it is now possible to summarize the steps taken in the research process to give a better understanding of this study.

Also, by doing so, the research and investigative questions can be related to these steps in the sense that they will be answered along the performed steps.

The following list summarizes the steps taken in the research design to answer the research and investigative questions:

1. Using the Taxonomy-Based Risk Identification Method (TRI) proposed by Carr in Taxonomy-Based Risk Identification(1), the researcher has adapted the TRI to fit the specific situation under this study, that is, the implementation of SILOMS in the MoD. The new taxonomy was named as MoD-SILOMS Taxonomy Risk Identification Method (MSTRI) – see Figure 8.

2. The TRI method has a derived Taxonomy-Based Questionnaire (TBQ), and the researcher has adapted the TBQ to fit the specific situation under this study. The new questionnaire was named as MoD-SILOMS Taxonomy-Based Questionnaire (MSTBQ) – see Appendix A.

3. The MSTBQ was used to conduct interviews with key people in MoD's agencies as highlighted in Figure 11.

4. The qualitative and quantitative data collected in the interviews were gathered through questions designed in the MSTBQ. The first ones gathered through the use of open-ended questions and the last ones, gathered through the use of objective or standard questions.

5. The open-ended questions were used to give the researcher more flexibility in gathering data related to a few central issues that had to be observed in the study. Also, the open-ended questions gave the researcher the opportunity of gathering unexpected information since the interviewees could come up with new revealing issues related to the study.

6. The objective or standard questions were designed and used to obtain numerical values, through the use of a rating scale system, based on the so-called Likert scales. Also a rank order procedure was performed in each section of the MSTBQ to allow the assignment of weights, which were given by interviewees' opinion according to the relative importance of the parameter compared to others.

    - The numerical values were assigned to the parameters (each one a question itself) being considered under the scope of the research, that is, the risks factors, attributes, and elements under the *Program Constraints Class*, defined in the MSTRI and shown in Figure 10.

7. Each parameter aforementioned was strictly related to the parameter immediately above according to a hierarchy shown in Figure 10 and detailed in Table 5. This parameters' hierarchy of dependencies and relationships, combined with the numbers assigned to them, turned in a framework that have made possible a overall numerical assessment of the *Program Constraints Class,* interpreted as a probability of success of the implementation of SILOMS in the MoD - limited to the defined scope of this study. See Figure 8 and Figure 10.

8. The probability of the successful implementation of the *Program Constraints Class* was then, calculated according the adaptation of SERIM's method using the following formulations – see Appendix E:

   a. $P(A2) = [\Sigma^3_{n=1} w_n P(An)]/3$ assuming that the weight of each element differs between them, then $P(A) = w_1 P(A_1) = w_2 P(A_2) + w_3 P(A_3)$ where each w_i is a positive number and $w_1 + w_2 + w_3 = 1$.

   b. $P(A2.n) = [\Sigma^6_{n=4} w_n P(A2.n)]$ where:

      i. A2n is the metric value for the factors identified in Table 3, and related to the element being measured

      ii. w_n is the weight assigned according risk factor's influence against risk elements.

   c. $P(A2.n.q) = [\Sigma^q_{n=1} P(Qn)]/8$ where Qn is the metric value for the question number Qn identified as related to the factor being measured.

   d. P(Development Phase) = Σ(All values assigned to the questions related to the developmental phase)/number of questions.

   e. P(Software Management Activity) = Σ(All values assigned to the questions related to the software management activity)/number of questions.

This subsection has summarized all the steps taken to perform this study.

Population and Sampling Information

This section describes the population involved in this study as well as the sampled organizations that will take part of this research.

The population will be the MoD's logistics agencies and related Brazilian's Navy (MB), Army (EB), and Air Force (FAB) organizations. Since the focus will be on the organization, cultural and political aspects that can threat the successful implementation of SILOMS in the MoD's agency SELOM and only explored within middle and high-level managers of MoD's agencies, then, the sample will be the MoD's agencies highlighted in Figure 11.

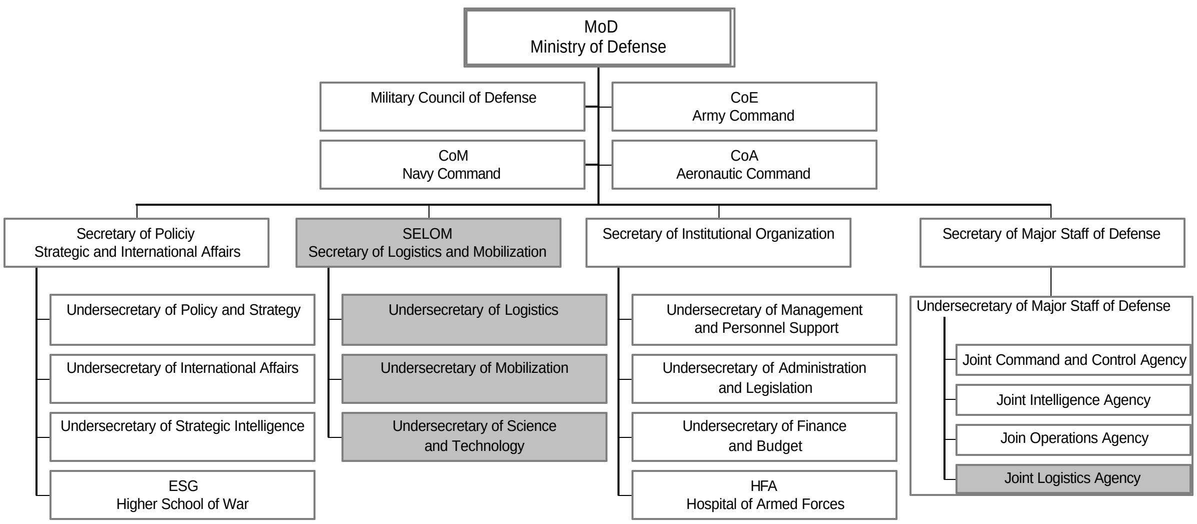

Figure 11. Brazil's Ministry of Defense – Highlighted Logistics Agencies.

This section has described the population involved in this study as well as the sampled elements and provided a graphical view of the organizations being researched.

Nature of the Data

This section describes the nature of data gathered in the research process as well as the data collection method.

The data will consist in qualitative assessment made possible by researcher's observation and the use of open-ended questions in the MSTBQ and also by quantitative assessment in objective questions that have scores associated with.

Data will be extracted from researcher's observations, as a relative outsider from interviews with the managers of the sectors in the MoD highlighted in Figure 11. The interviews will be focused on the adapted MSTRI and its derived MSTBQ - Appendix A - concerning the *Program Constraint Class*.

This section has described the nature of the data gathered in the research process as well as the data collection method, through MSQ, applied to this study.

Chapter Summary

This chapter has described the procedures taken during the research process to achieve its objectives. It has described the research design, and data analysis method, in order to answer the *Investigative Questions* and consequently answering the *Research Question* stated in Chapter I. Also, this chapter has presented the population involved in the study as well as the sampling information, which consisted in a few carefully selected agencies in the MoD. Finally, this chapter has described the nature of the data involved in the study.

IV. Results

Introduction

By giving a numerical assessment of the risks factors, attributes and elements under the Program Constrain Class – MSTRI – the investigative questions will be answered. Also, the answers are expected to direct the use of the method as a framework to help the decision makers to decide whether or not to implement SILOMS in the MoD's agency SELOM.

The main purpose of this chapter is to present the results of the study and answer the investigative questions described in Chapter 1. The data obtained through the use of MSTQ, from open-ended questions and objective or standard question are presented in the first section. The second section analyzes and interprets the data obtained. The third section uses the force field analysis to provide an overall picture of the forces acting in the SILOMS's implementation in the MoD. The fourth section answer the investigative questions stated in Chapter 1. Finally the chapter summary is presented.

Results

This section present the results obtained in the interviews performed with key personnel in the MoD's agencies according to the agencies highlighted in Figure 11. The first subsection shows the data gathered from the open-ended questions within the MSTBQ. The second subsection shows data gathered from the objective or standard questions in tables that summarize the scores obtained.

Open-ended Questions – Additional Issues

This subsection shows the open-ended questions that were used to assess the interviewees' subjective opinions and perceptions related to specific issues of software development knowledge about SILOMS. These questions helped the researcher gather information and draw conclusions that would not be possible with other types of question.

Some issues were raised while asking the interviewees their perception of SILOMS and its insertion in the MoD. This was done before asking them the objective or standard questions to avoid giving the interviewees hints about the risk taxonomy already established in the MSTBQ. The main points were:

- Concerns about differences in cultures within the military - raised in three out of four interviews.
- Concerns about the feasibility of the implementation of an integrated database integrating the three military branches and the reliability of such database - raised in one out of four interviews. He argued that even within a single military organization, such a system would challenge the actual status.

Objective or Standard Questions – MSTBQ's - Parameters Results

This subsection shows data gathered from the objective or standard questions. Table 6 shows the summary of the parameter's ranks given by the interviewees'. Table 7 contains the scores given to the parameters listed in Table 5 - according the rating scale and rank order processes described in Chapter III.

Complete tables of objective questions' scores obtained from each interview using MSTBQ are shown in Appendix D.

Table 6. Summary of Parameters' Ranks

Program Constraint Class - Ranks to Elements				
Metric	**Inerview**			
Element	**1**	**2**	**3**	**4**
A2.1	N/A	N/A	N/A	N/A
A2.2	N/A	N/A	N/A	N/A
A2.3	N/A	N/A	N/A	N/A
A2.4	2	3	1	2
A2.5	3	2	3	3
A2.6	1	1	2	1
Program Constraint Class - Ranks to Attributes				
Metric	**Interview**			
Attribute	**1**	**2**	**3**	**4**
A2.4.1	3	2	1	2
A2.4.2	2	1	2	1
A2.4.3	1	3	3	3
A2.5.1	2	2	2	2
A2.5.2	1	1	1	1
A2.6.1	2	1	1	1
A2.6.2	1	2	2	2

Table 7. MSTBQ - Responses to Objective Questions

MSTBQ Responses											
Parameter	Interview nº				Average	Parameter	Interview nº				Average
	1	2	3	4			1	2	3	4	
Factor						Probability Assesment					
A2.4.1.1	0.50	0.20	0.50	0.80	0.50	Class					
A2.4.1.2	0.20	0.50	0.50	0.20	0.35	P(A2) - Weight	0.71	0.82	0.68	0.86	**0.77**
A2.4.1.3	0.80	1.00	0.80	1.00	0.90	P(A2) - No Weight	0.67	0.81	0.69	0.86	0.76
A2.4.2.1	0.80	1.00	0.80	1.00	0.90						
A2.4.2.2	0.80	1.00	0.50	1.00	0.83	Element					
A2.4.2.3	1.00	1.00	0.80	1.00	0.95	P(A2.4)	0.71	0.82	0.65	0.81	0.75
A2.4.3.1	0.50	0.80	0.50	0.50	0.58	Rank Order A2.4	*2*	*3*	*1*	*2*	
A2.4.3.2	1.00	1.00	0.80	1.00	0.95	P(A2.5)	0.53	0.71	0.68	0.88	0.70
A2.5.1.1	0.50	0.20	0.80	0.80	0.58	Rank Order A2.5	*3*	*2*	*3*	*3*	
A2.5.1.2	0.20	0.80	0.50	0.80	0.58	P(A2.6)	0.79	0.89	0.74	0.88	0.82
A2.5.1.3	1.00	1.00	0.80	1.00	0.95	Rank Order A2.6	*1*	*1*	*2*	*1*	
A2.5.2.1	0.20	0.50	0.50	0.80	0.50						
A2.5.2.2	0.80	1.00	0.80	1.00	0.90	Attribute (Equal Weights)					
A2.6.1.1	0.80	1.00	0.80	1.00	0.90	P(A2.4.1)	0.50	0.57	0.60	0.67	0.58
A2.6.1.2	1.00	1.00	0.80	1.00	0.95	P(A2.4.2)	0.87	1.00	0.70	1.00	0.89
A2.6.1.3	1.00	0.80	0.80	1.00	0.90	P(A2.4.3)	0.75	0.90	0.65	0.75	0.76
A2.6.1.4	0.80	0.80	0.50	0.80	0.73	P(A2.5.1)	0.57	0.67	0.70	0.87	0.70
A2.6.1.5	1.00	0.80	0.50	1.00	0.83	P(A2.5.2)	0.50	0.75	0.65	0.90	0.70
A2.6.2.1	0.50	0.80	0.80	0.80	0.73	P(A2.6.1)	0.92	0.88	0.68	0.96	0.86
A2.6.2.2	0.80	1.00	0.80	0.80	0.85	P(A2.6.2)	0.65	0.90	0.80	0.80	0.79

Analysis – Interpreting Results

From Table 7 it is possible to review the data and interpret the meaning of the scores. The score labeled as P(A2), shown in the summary table, is interpreted as the probability of success related to the *Program Constraints Class*, considering the organizational, cultural and political aspects of the implementation of SILOMS in the MoD.

The interviews were gathered from four different subjects, and differences were expected and are due to the fact that the assignment of numeric values to risk parameters is subjective and different respondents based their responses upon their past experiences related to software development. In order to analyze the responses it is necessary to address each one separately.

In Table 8 is possible to compare the responses to P(A2) according each interview taken separately. The probability assessment has its lowest value of 0.68 from interview number 3, and its biggest value of 0.86 from interview number 4.

Table 8. Probability Assessment per Interview

MSTBQ Responses - Class A2				
Interview nº	**1**	**2**	**3**	**4**
Probability Assessment				
P(A2) - Weighted	0.71	0.82	0.68	0.86

The average taken over the four probability assessment is 0.77. If we assume that:

- The average value taken from the individual results of each interview is appropriate to predict P(A2), and
- The result of P(A2) can be extrapolated to the entire project, that is, implementation of SILOMS in the MoD.

Then the average taken from the individual scores in Table 8 can be interpreted as the probability of successful implementation of SILOMS in the MoD. And the overall result is 77%.

On the other hand, the results from interviews three and four show considerable disagreements in the responses to the probability assessment of class A2. For instance, if we compare the results obtained from these interviews (the third one with 0.68, and the fourth, with 0.86) there is a maximum difference of 0.18 in the probability assessment.

One approach to solve this problem is to use the so called “Delphi Method”, where the results from individual interviews or assessment could be confronted in meetings with the participants in order to obtain an agreement about the most reasonable response to the parameters through a process of discussions based on each individual experience and expertise. As a result of such meetings, the agreed scores to the parameters would be considered the most appropriate. This approach was not use in this research due to time constraints.

It is also interesting to note that the scores obtained for the factors in interview three shows a central tendency, that is, alternating from 0.5 and 0.8 as opposed to the remaining three interviews that were scored with more alternatives within the Likerts scale (from 0.2 through 1.0). Then, another approach to deal with this difference is to not consider the data from respondent three, since the data obtained provides little insight.

If only interviews one, two, and four are considered, the average obtained in those interviews, will be 0.79. In this case, the probability of successful implementation of SILOMS in the MoD is 79% compared with 77% taken over all interviews.

Sensitivity Analysis – Force Field Analysis

This section presents the force field analysis for the responses obtained from the MSTBQ. The results were used as a basis to illustrate the data shown in Table 7.

Each one of the following figures represents the results obtained from the interviews taken separately and identified with differentiated dotted arrows. Also a resultant force identified by a non-dotted arrow was calculated using the simple average from all four interview's results for the parameters being considered.

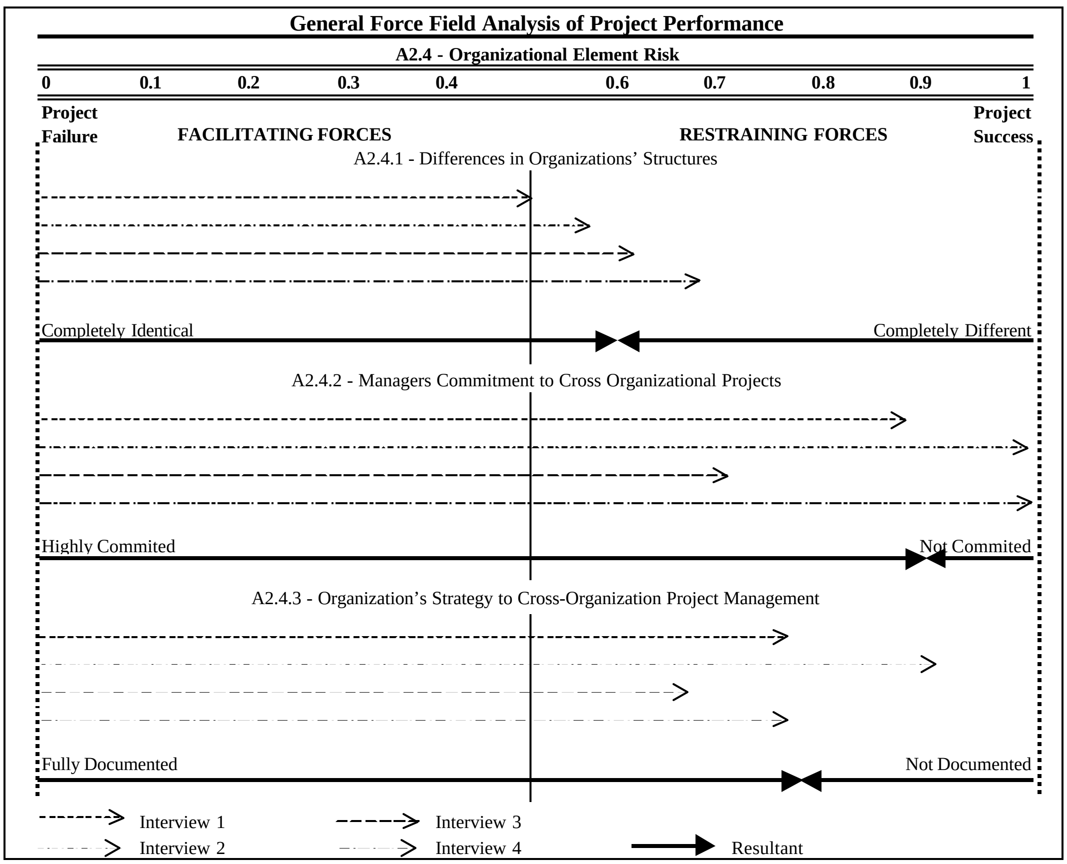

Figure 12. Force Field Analysis to Attributes within Organizational Element Risk

Figure 12 represents the force field analysis taken over the attributes within the *Organizational Risk Element* (A2.4), if we assume that:

- The simple average over the interviews' response is appropriate to predict the attributes' probability assessment, and
- Each attribute has the same weight in relation with the result over P(A2.4).

Then, within the *Organizational Element Risk* (A2.4), the attribute *Differences in Organization's Structures* (A2.4.1) is the one that requires special attention from the project manager since it has the higher restraining force toward project's failure.

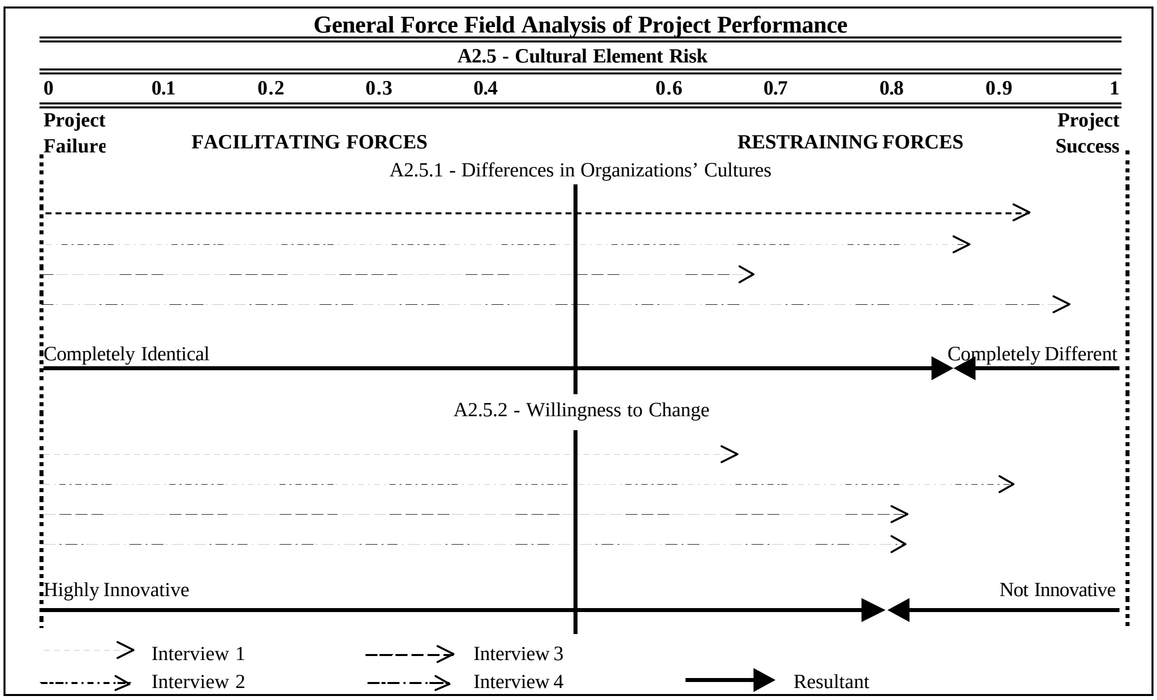

Figure 13. Force Field Analysis to Attributes within Cultural Element Risk

Figure 13 represents the force field analysis taken over the attributes within the *Cultural Element Risk* (A2.5), if we assume that:

- The simple average over the interviews' response is appropriate to predict the attributes' probability assessment, and

- Each attribute has the same weight in relation with the result over P(A2.5).

Then, within the *Cultural Element Risk* (A2.5), the attribute *Willingness to Change* (A2.5.2) is the one that requires special attention from the project manager since it has the higher restraining force toward project's failure.

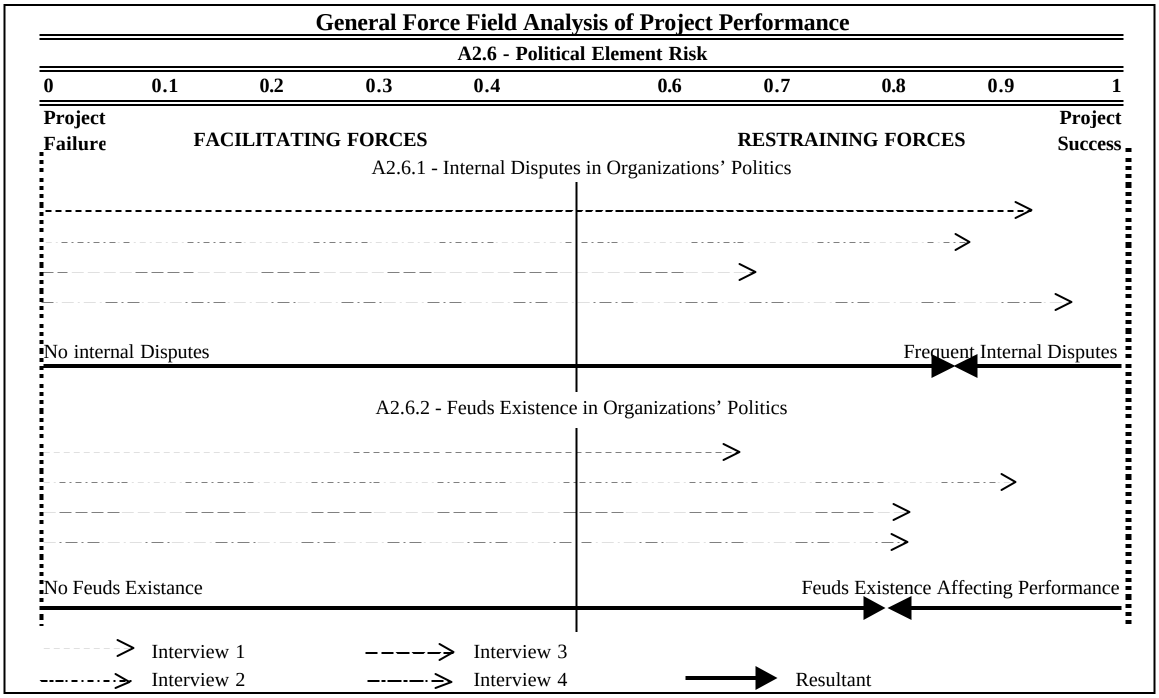

Figure 14. Force Field Analysis to Attributes within Political Element Risk

Figure 14 represents the force field analysis taken over the attributes within the *Political Element Risk* (A2.6), if we assume that:

- The simple average over the interviews' response is appropriate to predict the attributes' probability assessment, and

- Each attribute has the same weight in relation with the result over P(A2.6).

Then, within the *Political Element Risk* (A2.5), the attribute *Feuds Existence in Organization's Politics* (A2.6.2) is the one that requires special attention from the project manager since it has the higher restraining force toward project's failure.

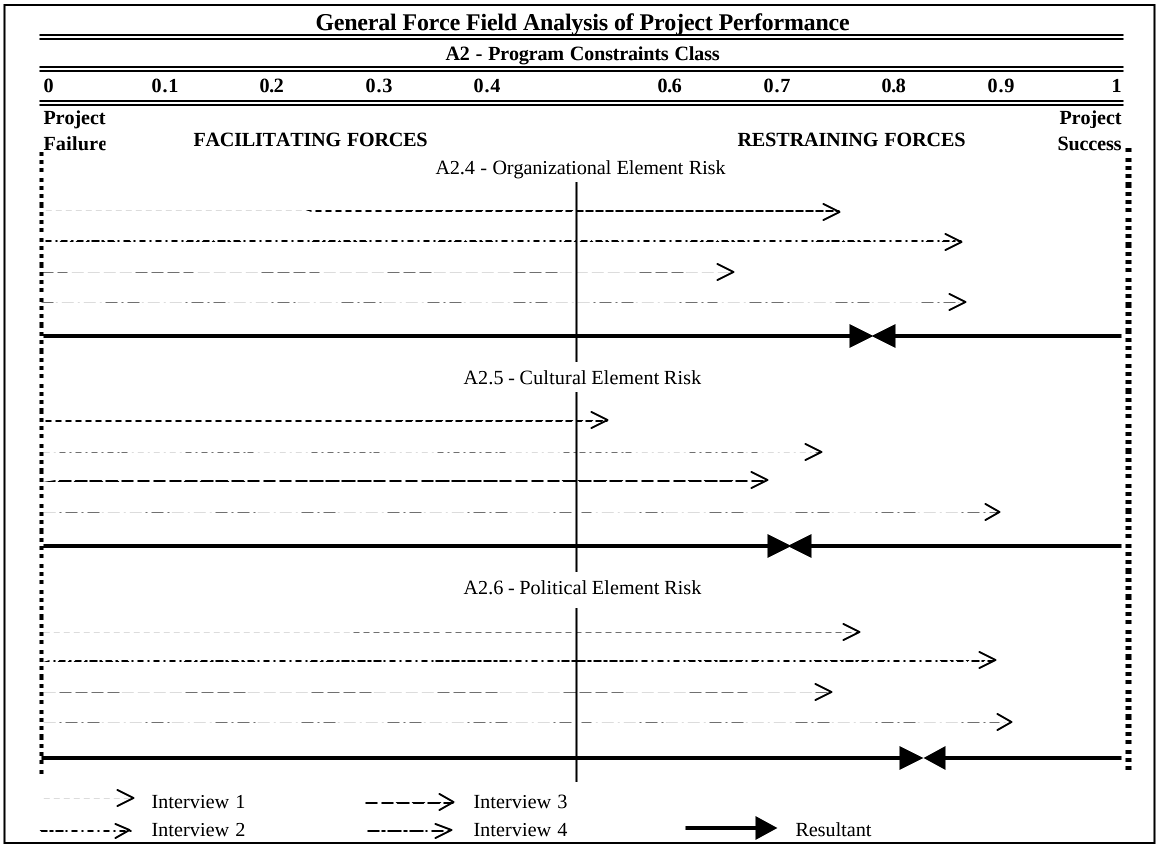

Figure 15. Force Field Analysis to Risk Elements within Program Constraints Class

Figure 15 represents the force field analysis taken over the risk elements within the *Program Constraints Class* (A2), if we assume that:

- The simple average over the interviews' response is appropriate to predict each elements' probability assessment, and
- Each element has the same weight in relation with the result over P(A2).

Then, within the *Program Constraints Class* (A2), the parameter *Cultural Element Risk* (A2.5) is the one that requires special attention from the project manager since it has the higher restraining force toward project's failure. Notice that this risk element has the higher restraining force, acting toward the worst state, which is 30% against the project's success. This can be seen also in Table 7.

The same force field analysis could have been used after considering the two approaches suggested in the previous section, that is, to deal with the data gathered from interview number three. First, in that case, after performing the "Delphi Method", the force field analysis would only consider scores obtained in the agreement. Second, if data from interview three was considered not reliable, then the same pictures could have been drawn using the three selected interviews.

Investigative Questions

This section uses the analysis performed in the previous sections to answer each one of the investigative questions "What are the factors critical to the successful implementation of SILOMS in the MoD?" can be answered by the use of MSTRI, which elicit the factors and considerations that may turn into a threat to the implementation of SILOMS in the MoD. Besides, the force field analysis shows how sensitive is each one of the factors or parameter, in relation with project's success.

The second investigative question "What is an appropriate method available to assess or predict risks involved in the implementation of SILOMS in the MoD?" can be answered in the

way that an appropriate method is the use of MSTRI and its derived MSTQ to perform interviews with key personnel related to SILOMS implementation in the MoD.

The answer to the third investigative question "How would we quantify the degree of risks in order to help the decision making process of adopting SILOMS in the MoD?" is that the use of a combination of SERIM and Force Field Analysis methodologies, as show in this research, can give a quantification or the degree of risks involved in the implementation of SILOMS in the MoD.

The answer to the fourth investigative question "Can a probability of success be obtained from this methodology?" is affirmative, and for instance, the method applied within the scope of this research, showed a probability of approximately 77% of project's success, considering the *Program Constraints Class* in the MSTRI.

Chapter Summary

This chapter addressed the investigative questions described in Chapter 1 and also presented the summary of scores given to the parameters associated with the *Program Constraints Class,* in relation to the implementation of SILOMS in the MoD. Research results obtained through the use of MSTQ and following analyzes and interpretations of the data were presented. Finally the results from the force field analysis were presented.

V. Conclusions

Introduction

This chapter synthesizes the findings of this study. In the first section, the research question will be revisited and conclusions will be drawn based on the results and analysis performed in Chapter IV. The second section describes the limitations of this study. The third section makes recommendations related to the use of the method proposed as well as to the successful implementation of SILOMS in the MoD. The fourth section will point out issues for future research. Finally a chapter summary will be presented.

Conclusions

After analyzing the results obtained from the use of the method applied in the implementation of SILOMS in the MoD, then, in this point, the research is able to answer the *Research Questions* stated in Chapter 1. That is "How to assess the feasibility and risks of the implementation of SILOMS in the MoD?"

The answer comes through the description of what was performed so far in the research process:

- The double approach in the research design, which is qualitative and quantitative studies, has been used as a way to compensate the gaps that exits in each separately approach.
- It was introduced a method that addresses and predict the risks involved in software development or implementation projects.

- The method was tested in the case of the implementation of SILOMS in the MoD, limited to the organizational, cultural, and political aspects that can threat the project's success.

- The proposed method provides qualitative and quantitative data to support the MoD's decision makers in evaluating alternatives available for the implementation of any information system in the MoD.

- The method can be easily extended to address other areas of risks identified in MSTRI, and then, giving a better judgment about the risks involved in the implementation of SILOMS in the MoD.

Also, there are some reasons to support the aforementioned conclusions:

- The method was tested in a real-world scenario, and despite the fact that was limited for a few aspects of the MSRI taxonomy, the results proved to be useful in the decision making process or deciding over the best alternative available.

- The method has provided an overall assessment of the probability of success involved in the case studied.

- The method is fairly easy to be applied.

- Given the importance in choosing a logistics information system that integrates the supply chain management in the MoD, then the use of a methodology that deals with risks and probability of software project's success has to be used in the evaluation of the alternatives.

Limitations

The method was only applied considering the organizational, cultural and political aspects, under the Program Constraints Class – MSTRI. Also the weighting process was implemented only in relation of the elements within the Program Constraints Class, although the method could have been used to consider weights in any level, that is, every factor, attribute, element and class considered in the proposed taxonomy.

Another limitation was the time constraint that prevented the implementation of a procedure to minimize disagreements within the set of interviewers. One approach could be to perform a "Delphi Method" in order to minimize those disagreements and also give a more reliable overall assessment of the probability of success. Another approach could be to not consider data from interviews that apparently shows some sort of bias or not plausible explained tendency.

Recommendations

Since the method was tested in a real-world environment, it could be useful to extend the method to cover a complete assessment of SILOMS' implementation in the MoD.

If the methodology is chosen to be applied, then, it is recommended that the people that will conduct the interviews and tabulate the data gathered has to be instructed in detail about how the method works. Also, is strongly recommended the participation of SILOMS implementation's project manager in the process of choosing the main parameters and in the definition of the sample that will take part of the assessment.

Also is strongly recommended that futures use of the method have to consider other organizations involved in SILOMS due to the fact, that such an integrated system has the database reliability strongly relied upon lower levels of management and operations. These organizations could be those dealing with SILOMS in each branch of military. That is, the sample used to perform the MSTBQ have to consider the operational or end-users in the Brazilian's Army, Navy and Air Force, in order to get an overall picture of the risks involved in the implementation of SILOMS in the MoD.

Future Research

Future research could be the test of the proposed methodology to aggregate the so-called "Delphi Method" and compare the differences with the results obtained from the simple average taken over the scores obtained in each interview.

Chapter Summary

This chapter has synthesized the findings of this study. In the first section, the research question was resembled and conclusions were drawn based on the results and analysis performed in Chapter IV. The second section has described the limitations of this study and the third section presented some recommendations related to the use of the method proposed as well as to the successful implementation of SILOMS in the MoD. Finally the last section pointed out issues for future researches.

Appendix A. MoD-SILOMS Taxonomy-Based Questionnaire – MSTBQ

Interview Form

This questionnaire was developed based on examples and methodologies from (1:A14-B24; 6:43-75) and according researcher experience in the field.

A. Describing SILOMS

SILOMS is a project started in 1993 aiming to achieve an integration o the information systems within the Brazilian Air Force (FAB) Materiel Command (COMGAP). The Integrated Systems of Logistics Materiel and Services (SILOMS) integrates in a single corporate database system all logistics information related to maintenance, supply, and transportation within the COMGAP. The overall goal of the system is to provide information to support the logistics decisions makers at all three levels within COMGAP's organizations to control and manage assets, including weapon systems and related equipment, as well as track needs during systems' life cycle. The system will also provide a clear vision of the movement of materials within the depots and related bases. Another important feature of the system is to allow a variety of queries in the corporate database to collect statistical data that could help the measurement of key performance parameters related to maintenance activities as well as reliability and availability of the assets being controlled.

B. Purpose of the Research

ASSUMPTION: There is a need for a logistics information system in the MoD

With some adaptations, the system has the capability to fill in the gap that exists in the MoD's Logistics and Mobilization Agency (SELOM), by allowing integrated management of all

needs within the military in supporting their weapon systems. SILOMS may be used, for instance, in helping identify similar parts needed by all defense organizations and allowing SELOM to employ a consolidated acquisition of supplies, thereby promoting savings and improving the efficiency of the weapon system acquisition process and their associated life cycle.

The objective of this research is to provide a method to measure the effort and feasibility of using SILOM's functions in the SELOM's environment.

a) Critical Issues in SILOMS Implementation

The implementation of an integrated information system has inherent challenges. Differences in organization culture, or in the way tasks are performed, are key issues to be observed in attempting to do so. The same is applicable when trying to adapt an already existing system to fill in the need of another organization. In such new environment, a key issue is to assess the feasibility of proceeding with an adaptation of an existing information system or if it is better to build a complete new system. If SELOM chooses to use the SILOM, what has to be done to assure the success of its implementation in MoD?

C. Demographic Data [Questions 100-105]

[100] What is your rank and position in the organization's hierarchy?

[101] What is the mission of the organization of which you are a part?

[102] What is your current job?

[103] What are your technical qualifications?

[103.a] Do you have a background in logistics?

[103.b] Do you have a background in System Analysis or Software Engineering?

[104] What is your experience (in terms of years) in this position in the organization's hierarchy?

[105] Have you worked in any development of an information system?

(Yes) [105.a] What was you job?

(No) [105.b] Are you familiar with IS development process?

First Open-ended Question (Before getting the "standard data" over the "elements" data) [OEG – Open-Ended Question]

[OEG] In your opinion, based on your background and this scenario, what kind of problems or issues do you think that may appear in such attempt? I mean, adapting SILOMS to the MoD environment?

D. Scoring Methods

The scoring method for the question that follows this section was based on Karolak in Software Engineering Risk Management. Software risk metrics measure items associated with software risk factors provide an indication of software risks viewed from several sources of information. Using metrics associated. Software risk metrics are numeric values generated from questions. The answers to the questions are then used to measure the characteristics of the software risk factors. A subjective numeric value which ranges anywhere from 0 to 1 is assigned by the person in response to the metric question. (6:51-52)

Answers to the questions should use the following scale as a general reference:

0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

Figure 16. Scale as a general reference – Extracted from Karolak (6:52)

E. Program Constraints Class

This section define the *Program Constraint Class*, the *Elements* and *Attributes* as well their *Factors* under the MSTRI, which identifies the risk associated with software development by associating questions in this interview, which in turn, generate metrics to measure the *Factors, Attributes, Elements* to get an overall risk assessment of the *Program Constraint Class* related to the implementation of SILOMS in the MoD. The use of the scale defined above helps to come up with tables that relate software risk metrics to the intended

Program Constraint Class consists of the "external" of the project – the factors that are outside the direct control of the project but can still have major effects on its success. Program constraints include the following elements and their definitions:

- *Organizational elements* – The external constraints imposed in the project due to differences in the hierarchy/organochart of the participating organizations interacting in the project.

- *Cultural elements* – The external constraints impose in the project due to differences between the participating organizations, in the "way their employees perceive and how this perception creates a pattern of beliefs, values, and expectations" (Gibson:30).

- *Political elements* – External constraints such as behavior outside the legitimate, recognized power system, designed to benefit an individual or subunit, often at the expense of the project organization in general or designed to acquire and maintain the power or "status quo" of the organizations involved in the project.

- *Resources elements* – The external constraints imposed on schedule, staff, budget, or facilities.

- *Contract elements* – The terms and conditions of the project contract.

- *Program interface elements* – The external interfaces to customers, other contractors, corporate management, and vendors.

Under the scope of this research and due to the fact that there is no approved project and/or contract, the interview will only be related to the first three elements, that is, organizational, cultural and political elements in the Program Constraint Class.

Program Constraints Class – Questions

The following three sections include questions that are used to measure software development risk associated with "Program Constraint Class" according to MSTRI.

1. Organizational Elements (Risk Organizational) – A2.4

The following questions are used to measure the software development risk associated with the attributes and factors related to "Organizational Element Risk" under the "Program Constraint Class" according to MSTRI.

Initial Open-ended Question for Organizational Element Data [OEO]

[OEO1] What kind of problems or issues could you foresee if you were supposed to use a system developed by the Air Force and consequently reflecting its organizational structure?

a. <u>Differences in Organizations Structures – Attribute (A2.4.1)</u>

A value of 0 indicates that the organization's structures differ completely. A value of 0.5 indicates there are some differences in the organizations structures, but not significantly. A value of 1 indicates no differences in the organizations structures.

[A2.4.1.1] Do you think that other branches of military's organization structures differ significantly from your branch?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

[A2.4.1.2] Do you think that this/these differences may jeopardize the implementation of SILOMS in the MoD?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

Obs: The scale in this question is inverted, that is, when the interviewed answered that he/she strongly agree that differences in organizations structures may jeopardize the implementation, the score 0 was assigned, and when he/she strongly agree that none of differences in organizations structures may jeopardize the implementation, the score 1 where assigned.

[A2.4.1.3] Do you agree that despite the fact that may exist significantly differences in military's organizational structures, the implementation of SILOM in the MoD can be successful?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

2.4.1 - Differences in Organizations Structures - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.1.1				
A2.4.1.2				
A2.4.1.3				
		Attribute Average Final Value		

Table 9. Rank-Order and Weight Process to *Factors* in the *Attribute* "Differences in Organizations Structures".

b. Managers Commitment to Cross-Organizational Projects- Attribute(A2.4.2)

A value of 0 indicates that Managers Commitment to Cross-Organization's Projects is not perceived by the interviewed. A value of 0.5 indicates that in some cases, Managers Commitment to Cross-Organization's Projects is easily perceived. A value of 1 indicates full Managers Commitment to Cross-Organization's Projects.

[A2.4.2.1] When you were working with other military branch's personnel, did you feel that your boss/senior managers were committed to the work/activity/project?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

[A2.4.2.2] Did/Do you feel that your motivation and commitment were/is high when working with other military branch's personnel?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

[A2.4.2.3] Would you describe this experience as a enjoyable experience?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

A2.4.2 Managers Commitment to Cross Organizational Projects - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.2.1				
A2.4.2.2				
A2.4.2.3				
		Attribute Average Final Value		

Table 10. Rank-Order and Weight Process to *Factors* in the *Attribute* "Managers Commitment to Cross-Organizational Projects".

c. <u>Organization Strategy to Cross-Organizational Project Management - Attribute(A2.4.3)</u>

A value of 0 indicates there is no documented Organization Strategy to Cross-Organizational Project Management. A value of 0.5 indicates that there is no documented Organization Strategy to Cross-Organizational Project Management but managers and employees involved in such activities know the communication lines of authority, or there is a documented Organization Strategy to Cross-Organizational Project Management but it is not correct/updated. A value of 1 indicated that there is a documented Organization Strategy to Cross-Organizational Project Management and it indicated how to deal with this kind of activities.

[A2.4.3.1] Does your organization have a specific written strategy to deal with cross-organizational projects? (e.g., document, statement of policy, operating instructions?)

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

[A2.4.3.2] Do you think that this kind of document/strategy is important to your organization's performance?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

A2.4.3 Organization Strategy to Cross-Organizational Project Management- Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.3.1				
A2.4.3.2				
		Attribute Average Final Value		

Table 11. Rank-Order and Weight Process to *Factors* in the *Attribute* "Organization Strategy to Cross-Organizational Project Management".

Last Open-ended Question to Organizational Elements Data [OEO]

[OEO2] What do you think about the Brazilian Air Force initiative in integrating the logistics functions in only one system?

Rank Order to Organizational Elements Data [ROO]

[ROO] If you were asked to rank order the previous attributes, from the most important to the less important, how it should be?

A2.4 Organizational Risk - Element				
Metric - Attribute	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.1				
A2.4.2				
A2.4.3				
		Attribute Average Final Value		

Table 12. Rank-Order and Weight Process to *Attributes* in the *Element* "Organizational Risk".

2. Cultural Element Risk (Risk Culture) – A2.5

The following questions are used to measure the software development risk associated with the attributes and factors related to "Cultural Element Risk" under the "Program Constraint Class" according to MSTRI.

First Open-ended Question to Cultural Elements Data [OEC]

[OEC1] How could you describe the culture in your organization and your department/agency?

d. <u>Differences in Organizations Cultures - Attribute(A2.5.1)</u>

A value of 0 indicates that the organization's culture differ completely. A value of 0.5 indicates there are some differences in the organizations culture, but not significantly. A value of 1 indicates no differences in the organizations cultures.

[A2.5.1.1] Do you think that other branches of military's organization cultures differ significantly from your branch?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

[A2.5.1.2] Do you think that this/these differences may jeopardize the implementation of SILOMS in the MoD?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

Obs: The scale in this question is inverted, that is, when the interviewed answered that he/she strongly agree that differences in organizations cultures may jeopardize the implementation, the score 0 was assigned, and when he/she strongly agree that none of differences in organizations cultures may jeopardize the implementation, the score 1 where assigned.

[A2.5.1.3] Do you agree that despite the fact that may exist significantly differences in military's organizational cultures, the implementation of SILOM in the MoD can be succesfull?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

A2.5.1 Differences in Organizations Cultures - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
2.5.1.1				
2.5.1.2				
2.5.1.3				
		Attribute Average Final Value		

Table 13. Rank-Order and Weight Process to *Factors* in the *Attribute* "Differences in Organizations Cultures".

e. Willingness to Change – Attribute(A2.5.2)

A value of 0 indicates you work for a progressive company, which is constantly changing in its decisions and culture. A value of 0.5 indicates you work for a moderately conservative company, which needs much information before a decision is made or tends to perform/produce activities/products that have been done in the past. A value of 1 indicates you work for a highly innovative company.

[A2.5.2.1] Is your company/organization culture conservative in its decision making?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

[A2.5.2.2] Does your company/organization tend to build or acquire new products and/or technologies?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

A2.5.2 Willingness to Change - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
2.5.2.1				
2.5.2.2				
		Attribute Average Final Value		

Table 14. Rank-Order and Weight Process to *Factors* in the *Attribute* "Willingness to Change".

Last Open-ended Question to Cultural Elements Data [OEC – Open-Ended Question]

[OEC2] Do you think that exists any cultural problems/issues that can make difficult the implementation of SILOMS in the MOD? Do you think that exists any cultural aspect, I mean, beliefs, patterns, standards, or any kind of behavior within your agency/department that may turn into a barrier to the implementation of SILOMS in the MoD?

Rank Order Question to Cultural Elements [ROC]

[ROC] If you were asked to rank order these (the following) issues, from the most important to the less important, how it should be?

A2.5 Cultural Risk - Element				
Metric - Attribute	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.5.1				
A2.5.2				
		Attribute Average Final Value		

Table 15. Rank-Order and Weigh Process to Attributes in the Element "Cultural Risk".

3. Political Element Risk (Risk Politics) – A2.6

The following questions are used to measure the software development risk associated with the attributes and factors related to “Political Element Risk” under the “Program Constraint Class” according to MSTRI.

First Open-ended Question to Political Element Data [OEP]

[OEP1] Do you think that your will have any political problems/issues in your agency/department if the ministry gives the approval to implement SILOMS in the MoD?

f. Internal Disputes in Organizations Politics – Attribute(A2.6.1)

A value of 0 indicates Internal Disputes in Organizations' Politics occurs frequently. A value of 0.5 indicates that Internal Disputes in Organizations' Politics occurs in a controllable way, that is, not affecting the organization's performance. A value of 1 indicates that no Internal Disputes in Organizations' Politics occurs.

[A2.6.1.1] What kind of commitment of the top-level managers are you expecting if they were asked to implement an information system developed by the Air Force?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

[A2.6.1.2] If you were asked to decide about the implementation of SILOMS in your organization would you approve it?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

[A2.6.1.3] If you were asked to decide about whether choose to develop your own information system or whether to adapt and already existing one, would you choose SILOMS?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

[A2.6.1.4] Would you agree that SILOMS, a system used by Air Force, can fulfill the needs of you agency/department in the MoD?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

[A2.6.1.5] If you were asked to give your opinion about whether to use a COTS or SILOMS, would you recommend SILOMS?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

A2.6.1 Internal Disputes in Organizations Politics - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.6.1.1				
A2.6.1.2				
A2.6.1.3				
A2.6.1.4				
A2.6.1.5				
		Attribute Average Final Value		

Table 16. Rank-Order and Weigh Process to *Factors* in the *Attribute* "Internal Disputes in Organizations Politics".

g. <u>Feuds Existence in Organizations Politics – Attribute(2.6.2)</u>

A value of 0 indicates that Feuds Existence in Organizations Politics highly affects organization's performance. A value of 0.5 indicates that Feuds Existence in Organizations Politics is moderate and occurs in a controllable way, that is, not affecting the organization's performance. A value of 1 indicates that there are no Feuds Existence in Organizations Politics.

[<u>A2.6.2.1</u>] Does good communication exist between different organizations supporting the development of the software project?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

[<u>A2.6.2.2</u>] If you were asked to give your opinion about the different small groups that may exist in your organization, would you say that they do not affects the organization's performance?

( )	( )	( )	( )	( )
0	0.2	0.5	0.8	1.0
None	A Little	Some	Most	All

A2.6.2 Feuds Existence in Organizations Politics - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.6.2.1				
A2.6.2.2				
		Attribute Average Final Value		

Table 17. Rank-Order and Weigh Process to *Factors* in the *Attribute* "Feuds Existence in Organizations Politics".

Last Open-ended Question to Political Elements Data [OEP]

[OEP2] Do you think that would exist any other political problems/issues in the implementation of SILOMS in the MoD?

Rank Order attributes to Political Element [ROP]

[ROP] If you were asked to rank order these (the following) issues, from the most important to the less important, how it should be?

A2.6 Political Risk- Element				
Metric - Attribute	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.6.1				
A2.6.2				
		Attribute Average Final Value		

Table 18. Rank-Order and Weigh Process to Attributes the Element "Political Risk".

Rank Order Elements to Program Constraints Class

A2 Program Constraints - Class				
Metric - Element	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.1				
A2.2				
A2.3				
A2.4				
A2.5				
A2.6				
		Attribute Average Final Value		

Table 19. Rank-Order and Weigh Process to *Elements* in the *Class* “Program Constraints”.

<u>Appendix B</u>. SEI Taxonomy - Program Constraints Class

Program constraints refer to the "externals" of the project. These are factors that may be outside the control of the project but can still have major effects on its success or constitute sources of substantial risk.

1. Resources

This Element addresses resources for which the program is dependent on factors outside program control to obtain and maintain. These include schedule, staff, budget, and facilities.

a) Schedule

This attribute refers to the stability of the schedule with respect to internal and external events or dependencies and the viability of estimates and planning for all phases and aspects of the program.

b) Staff

This attribute refers to the stability and adequacy of the staff in terms of numbers and sill levels, their experience and skills in the required technical areas and application domain, and teir availability when needed.

c) Budget

This attribute refers to the stability of the budget with respect to internal and external events or dependencies and the viability of estimates and planning for all phases and aspects of the program.

d) Facilities

This attribute refers to the adequacy of the program facilities for development, integration, and testing of the product.

2. Contract

Risks associated with the program contract are classified according to contract type, restrictions, and dependencies.

e) Type of Contract

This attribute covers the payment terms (cost plus aware fee, cost plus fixed fee, etc.) and the contractual requirements associated with such items as the Statement of Work, Contract Data, Requirements List, and the amount and conditions of customer involvement.

f) Restrictions

Contract restrictions and restrints refer to contractual directives to, for example, use specific development methods or equipment and the resultant complications such as acquisition of data rights for use of non-developmental software.

g) Dependencies

This attribute refers to the possible contractual dependencies on outside contractors or vendors, customers-furnished equipment or software, or other outside products and services.

3. Program Interfaces

This element consists of the various interfaces with entities and organizations outside the development program itself.

h) Customer

The customer attribute refers to the customer's level of skill and experience in the technical or application domain of the program as well as difficult working relationships or poor mechanisms for attaining customer agreement and approvals, not having access to certain customer factions, or not being able to communicate with the customer in a forthright manner.

i) Associate Contractors

The presence of associate contractors may introduce risks due to conflicting political agendas, prolems of interfaces to systems being developed by outside organizations, or lack of cooperation in coordinating schedules and configuration changes.

j) Subcontractors

The presence of subcontractors may introduce risks due to inadequate task definitions and subcontractor management mechanisms, or to not transferring subcontractor technology and knowledge to the program or corporation.

k) Prime Contractor

When the program is a subcontract, risks may arise from poorly defined task definitions, complex reporting arrangements, or dependencies on technical or programmatic information.

l) Corporate Management

Risks in the corporate management area include poor communication and direction from senior management as well as non-optimum levels of support.

m) Vendors

Vendor risks may present themselves in the forms of dependencies on deliveries and support for critical system components.

n) Politics

Political risks may accrue from relationships with the company, customer, associate contractors or subcontractors, and may affect technical decisions.

<u>Appendix C</u>. **SEI TBQ - Program Constraints Class**

1. Resources

a. <u>Schedule</u>
[Is the schedule inadequate or unstable?]

[143] Has the schedule been stable?
[144] Is the schedule realistic?
(Yes) (144.a) Is the estimation method based on historical data?
(Yes) (144.b) Has the method worked well in the past?
[145] Is there anything for which adequate schedule was not planned?

- Analysis and studies
- QA
- Training
- Maintenance courses and training
- Capital equipment
- Deliverable development system

[146] Are there external dependencies which are likely to impact the schedule?

b. <u>Staff</u>
[Is the staff inexperienced, lacking domain knowledge, lacking skills, or understaffed?]

[147] Are there any areas in which the required technical skills, or understaffed?

- Software engineering and requirements analysis method
- Algorithm expertise
- Design and design methods
- Programming languages
- Integration and test methods
- Reliability
- Maintainability
- Availability
- Human factors
- Configuration management
- Quality assurance
- Target environment
- Level of security
- COTS
- Reuse software

- Operating system
- Database
- Application domain
- Performance analysis
- Time-critical applications

[148] Do you have adequate personnel to staff the program?
[149] Is the staffing stable?
[150] Do you have access to the right people when you need them?
[151] Have the program members implemented systems of this type?
[152] Is the program reliant on a few key people?
[153] Is there any problem with getting cleared people?

c. Budget
[Is the funding insufficient or unstable?]

[154] Is the budget stable?
[155] Is the budget based on a realistic estimate?
(Yes) (155.a) Is the estimation method based on historical data?
(Yes) (155.b) Has the method worked well in the past?
[156] Have features or functions been deleted as a part of a design-to-cost effort?
[157] Is there anything for which adequate budget was not allocated?

- Analysis and studies
- QA
- Training
- Maintenance courses
- Capital equipment
- Deliverable development system

[158] Do budget changes accompany requirement changes?
(Yes) (158.a) Is this a standard part of the change control process?

d. Facilities
[Are the facilities adequate for building and delivering the product?]

[159] Are the development facilities adequate?
[160] Is the integration environment adequate?

2. Contract

e. Type of Contract
[Is the contract type a source of risk to the program?]

[161] What type of contract do you have? (Cost plus award fee, fixed price,…)
(Yes) (161.a) Does this present any problems?
[162] Is the contract burdensome in any aspect of the program?

- SOW (Statement of Work)
- Specifications
- DIDs (Data Item Descriptions)
- Contract Parts
- Excessive customer involvement

[163] Is required documentation burdensome?

- Excessive amount
- Picky customer
- Long approval cycle

f. Restrictions
[Does the contract cause any restrictions?]

[164] Are the problems with data rights?

- COTS software
- Developmental software
- Non-developmental items

g. Dependencies
[Does the program have any dependencies on outside products or services?]

[165] Are there dependencies on external products or services that may affect the product, budget, or schedule?

- Associate contractors
- Prime contractor
- Subcontractors
- Vendors or suppliers
- Customer furnished equipment or software

3. Program Interfaces

h. Customer
[Are there any customer problems such as: lengthy document-approval cycle, poor communication, and inadequate domain expertise?]

[166] Is the customer approval cycle timely ?

- Documentation
- Program reviews
- Formal reviews

[167] Do you ever proceed before receiving customer approval?

[168] Does the customer understand the technical aspects of the system?
[169] Does the customer understand software?
[170] Does the customer interfere with process or people?
[171] Does management work with the customer to reach mutually agreeable decisions in a timely manner?

- Requirements understanding
- Test criteria
- Schedule adjustments
- Interfaces

[172] How effective are your mechanisms for reaching agreements with the customers?

- Working groups (contractual?)
- Technical interchange meetings (contractual?)

[173] Are all customers factions involved in reaching agreements?
(Yes) (173.a) Is is a formally defined process?
[174] Does management present a realistic or optimistic picture to the customer?

If there are associate contractors

i. <u>Associate Contractors</u>
[Are there any problems with associate contractors such as inadequately defined or unstable interfaces, poor communications, or lack of cooperation?]

[175] Are there external interfaces changing without adequate notification, coordination, or formal change procedures?
[176] Is there and adequate transition plan?
(Yes) (176.a) Is it supported by all contractors and site personnel?
[177] Is there any problem with getting schedules or interface data from associate contractors?
(No) (177.a) Are they accurate?

If there are subcontractors

j. <u>Subcontractors</u>
[Is the program dependent on subcontractors for any critical areas?]

[178] Are there any ambiguities in subcontractors task definitions?
[179] Is the subcontractor reporting and monitoring procedure different from the program's reporting requirements?
[180] Is subcontractor administration and technical management done by a separate organization?
[181] Are you highly dependent on subcontractor expertise in any areas?
[182] Is subcontractor knowledge being transferred to the company?
[183] Is there any problem with getting schedules or interface data from subcontractors?

If program is a subcontract

k. Prime Contractor
[Is the program facing difficulties with its Prime contractor?]

[184] Are your task definitions from the Prime contractor ambiguous?
[185] Do you interface with two separate prime organizations for administrations and technical management?
[186] Are you highly dependent on the Prime for expertise in any areas?
[187] Is there any problem with getting schedules or interface data from the Prime?

l. Corporate Management
[Is there a lack of support of micro management form upper management?]

[188] Does program management communicate problems to senior management?
(Yes) (188.a) Does this seem to be effective?
[189] Does corporate management give you timely support in solving your problems?
[190] Does corporate management tend to micro-manage?
[191] Does management present a realistic or optimistic picture to senior management?

m. Vendors
[Are vendors responsive to program needs?]

[192] Are you relying on vendors for deliveries of critical components?
- Compliers
- Hardware
- COTS

n. Politics
[Are politics causing a problem for the program?]

[193] Are politics affecting the program?
- Company
- Customer
- Associate contractors
- Subcontractors

[194] Are politics affecting technical decisions?

Appendix D. **Scores Obtained in interviews - MSTBQ – Weighted Scores**

Summary of Scores from Interview # 1 Organizational Element Risk				
2.4.1 - Differences in Organizations Structures - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.1.1	0.5	1	1	0.5
A2.4.1.2	0.2	1	1	0.2
A2.4.1.3	0.8	1	1	0.8
		Attribute Average Final Value		**0.5**
A2.4.2 Managers Commitment to Cross Organizational Projects - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.2.1	0.8	1	1	0.8
A2.4.2.2	0.8	1	1	0.8
A2.4.2.3	1	1	1	1
		Attribute Average Final Value		**0.866666667**
A2.4.3 Organization Strategy to Cross-Organizational Project Management-Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.3.1	0.5	1	1	0.5
A2.4.3.2	1	1	1	1
		Attribute Average Final Value		**0.75**
A2.4 Organizational Risk - Element				
Metric - Attribute	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.1	0.5	3	0.6	0.3
A2.4.2	0.866666667	2	0.9	0.78
A2.4.3	0.75	1	1.5	1.125
		Element Average Final Value # 1		**0.735**

Summary of Scores from Interview # 1 Cultural Element Risk				
A2.5.1 Differences in Organizations Cultures - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
2.5.1.1	0.5	1	1	0.5
2.5.1.2	0.2	1	1	0.2
2.5.1.3	1	1	1	1
		Attribute Average Final Value		**0.566666667**
A2.5.2 Willingness to Change - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
2.5.2.1	0.2	1	1	0.2
2.5.2.2	0.8	1	1	0.8
		Attribute Average Final Value		**0.5**
A2.5 Cultural Risk - Element				
Metric - Attribute	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.5.1	0.566666667	2	0.8	0.453333333
A2.5.2	0.5	1	1.2	0.6
		Element Average Final Value # 1		**0.526666667**

Summary of Scores from Interview # 1 Political Element Risk				
A2.6.1 Internal Disputes in Organizations Politics - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.6.1.1	0.8	1	1	0.8
A2.6.1.2	1	1	1	1
A2.6.1.3	1	1	1	1
A2.6.1.4	0.8	1	1	0.8
A2.6.1.5	1	1	1	1
		Attribute Average Final Value		**0.92**
A2.6.2 Feuds Existence in Organizations Politics - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.6.2.1	0.5	1	1	0.5
A2.6.2.2	0.8	1	1	0.8
		Attribute Average Final Value		**0.65**
A2.6 Political Risk- Element				
Metric - Attribute	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.6.1	0.92	2	0.8	0.736
A2.6.2	0.65	1	1.2	0.78
		Element Average Final Value # 1		**0.758**

Summary of Scores from Interview # 2 Organizational Element Risk				
2.4.1 - Differences in Organizations Structures - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.1.1	0.2	1	1	0.2
A2.4.1.2	0.5	1	1	0.5
A2.4.1.3	1	1	1	1
		Attribute Average Final Value		**0.566666667**
A2.4.2 Managers Commitment to Cross Organizational Projects - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.2.1	1	1	1	1
A2.4.2.2	1	1	1	1
A2.4.2.3	1	1	1	1
		Attribute Average Final Value		**1**
A2.4.3 Organization Strategy to Cross-Organizational Project Management-Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.3.1	0.8	1	1	0.8
A2.4.3.2	1	1	1	1
		Attribute Average Final Value		**0.9**
A2.4 Organizational Risk - Element				
Metric - Attribute	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.1	0.566666667	2	0.9	0.51
A2.4.2	1	1	1.5	1.5
A2.4.3	0.9	3	0.6	0.54
		Element Average Final Value # 2		**0.85**

Summary of Scores from Interview # 2 Cultural Element Risk				
A2.5.1 Differences in Organizations Cultures - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
2.5.1.1	0.2	1	1	0.2
2.5.1.2	0.8	1	1	0.8
2.5.1.3	1	1	1	1
			Attribute Average Final Value	**0.666666667**
A2.5.2 Willingness to Change - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
2.5.2.1	0.5	1	1	0.5
2.5.2.2	1	1	1	1
			Attribute Average Final Value	**0.75**
A2.5 Cultural Risk - Element				
Metric - Attribute	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.5.1	0.666666667	2	0.8	0.533333333
A2.5.2	0.75	1	1.2	0.9
			Element Average Final Value # 2	**0.716666667**

Summary of Scores from Interview # 2 Political Element Risk				
A2.6.1 Internal Disputes in Organizations Politics - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.6.1.1	1	1	1	1
A2.6.1.2	1	1	1	1
A2.6.1.3	0.8	1	1	0.8
A2.6.1.4	0.8	1	1	0.8
A2.6.1.5	0.8	1	1	0.8
		Attribute Average Final Value		**0.88**
A2.6.2 Feuds Existence in Organizations Politics - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.6.2.1	0.8	1	1	0.8
A2.6.2.2	1	1	1	1
		Attribute Average Final Value		**0.9**
A2.6 Political Risk- Element				
Metric - Attribute	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.6.1	0.88	1	1.2	1.056
A2.6.2	0.9	2	0.8	0.72
		Element Average Final Value # 2		**0.888**

Summary of Scores from Interview # 3 Organizational Element Risk				
2.4.1 - Differences in Organizations Structures - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.1.1	0.5	1	1	0.5
A2.4.1.2	0.5	1	1	0.5
A2.4.1.3	0.8	1	1	0.8
		Attribute Average Final Value		**0.6**
A2.4.2 Managers Commitment to Cross Organizational Projects - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.2.1	0.8	1	1	0.8
A2.4.2.2	0.5	1	1	0.5
A2.4.2.3	0.8	1	1	0.8
		Attribute Average Final Value		**0.7**
A2.4.3 Organization Strategy to Cross-Organizational Project Management-Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.3.1	0.5	1	1	0.5
A2.4.3.2	0.8	1	1	0.8
		Attribute Average Final Value		**0.65**
A2.4 Organizational Risk - Element				
Metric - Attribute	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.1	0.6	1	1.5	0.9
A2.4.2	0.7	2	0.9	0.63
A2.4.3	0.65	3	0.6	0.39
		Element Average Final Value # 3		**0.64**

Summary of Scores from Interview # 3 Cultural Element Risk				
A2.5.1 Differences in Organizations Cultures - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
2.5.1.1	0.8	1	1	0.8
2.5.1.2	0.5	1	1	0.5
2.5.1.3	0.8	1	1	0.8
		Attribute Average Final Value		**0.7**
A2.5.2 Willingness to Change - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
2.5.2.1	0.5	1	1	0.5
2.5.2.2	0.8	1	1	0.8
		Attribute Average Final Value		**0.65**
A2.5 Cultural Risk - Element				
Metric - Attribute	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.5.1	0.7	2	0.8	0.56
A2.5.2	0.65	1	1.2	0.78
		Element Average Final Value # 3		**0.67**

Summary of Scores from Interview # 3 **Political Element Risk**				
A2.6.1 Internal Disputes in Organizations Politics - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.6.1.1	0.8	1	1	0.8
A2.6.1.2	0.8	1	1	0.8
A2.6.1.3	0.8	1	1	0.8
A2.6.1.4	0.5	1	1	0.5
A2.6.1.5	0.5	1	1	0.5
		Attribute Average Final Value		**0.68**
A2.6.2 Feuds Existence in Organizations Politics - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.6.2.1	0.8	1	1	0.8
A2.6.2.2	0.8	1	1	0.8
		Attribute Average Final Value		**0.8**
A2.6 Political Risk- Element				
Metric - Attribute	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.6.1	0.68	1	1.2	0.816
A2.6.2	0.8	2	0.8	0.64
		Element Average Final Value # 3		**0.728**

Summary of Scores from Interview # 4 Organizational Element Risk				
2.4.1 - Differences in Organizations Structures - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.1.1	0.8	1	1	0.8
A2.4.1.2	0.2	1	1	0.2
A2.4.1.3	1	1	1	1
		Attribute Average Final Value		**0.666666667**
A2.4.2 Managers Commitment to Cross Organizational Projects - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.2.1	1	1	1	1
A2.4.2.2	1	1	1	1
A2.4.2.3	1	1	1	1
		Attribute Average Final Value		**1**
A2.4.3 Organization Strategy to Cross-Organizational Project Management-Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.3.1	0.5	1	1	0.5
A2.4.3.2	1	1	1	1
		Attribute Average Final Value		**0.75**
A2.4 Organizational Risk - Element				
Metric - Attribute	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.4.1	0.666666667	2	0.9	0.6
A2.4.2	1	1	1.5	1.5
A2.4.3	0.75	3	0.6	0.45
		Element Average Final Value # 4		**0.85**

Summary of Scores from Interview # 4 Cultural Element Risk				
A2.5.1 Differences in Organizations Cultures - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
2.5.1.1	0.8	1	1	0.8
2.5.1.2	0.8	1	1	0.8
2.5.1.3	1	1	1	1
		Attribute Average Final Value		**0.866666667**
A2.5.2 Willingness to Change - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
2.5.2.1	0.8	1	1	0.8
2.5.2.2	1	1	1	1
		Attribute Average Final Value		**0.9**
A2.5 Cultural Risk - Element				
Metric - Attribute	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.5.1	0.866666667	2	0.8	0.693333333
A2.5.2	0.9	1	1.2	1.08
		Element Average Final Value # 4		**0.886666667**

Summary of Scores from Interview # 4 Political Element Risk				
A2.6.1 Internal Disputes in Organizations Politics - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.6.1.1	1	1	1	1
A2.6.1.2	1	1	1	1
A2.6.1.3	1	1	1	1
A2.6.1.4	0.8	1	1	0.8
A2.6.1.5	1	1	1	1
		Attribute Average Final Value		**0.96**
A2.6.2 Feuds Existence in Organizations Politics - Attribute				
Metric - Factor	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.6.2.1	0.8	1	1	0.8
A2.6.2.2	0.8	1	1	0.8
		Attribute Average Final Value		**0.8**
A2.6 Political Risk- Element				
Metric - Attribute	**Value**	**Rank Order**	**Weight**	**Final Value**
A2.6.1	0.96	1	1.2	1.152
A2.6.2	0.8	2	0.8	0.64
		Element Average Final Value # 4		**0.896**

Appendix E. SERIM Method – Calculations applied to the implementation of SILOMS in the MoD

Class	Program Constraints		
	$P(A2) := \sum_{n=4}^{6} Wn(A2n)$		
Elements	**Organizational**	**Cultural**	**Political**
	$P(A24) := \sum_{n=1}^{3} Wn(A2n)$	$P(A25) := \sum_{n=1}^{2} Wn(A25n)$	$P(A26) := \sum_{n=1}^{2} Wn(A26n)$
Attribute	$P(A241) := \sum_{n=1}^{3} Wn(A241n)$	$P(A251) := \sum_{n=1}^{3} Wn(A251n)$	$P(A261) := \sum_{n=1}^{5} Wn(A261n)$
Attribute	$P(A242) := \sum_{n=1}^{3} Wn(A241n)$	$P(A252) := \sum_{n=1}^{2} Wn(A252n)$	$P(A262) := \sum_{n=1}^{2} Wn(A262n)$
Attribute	$P(A243) := \sum_{n=1}^{2} Wn(A241n)$		

Figure 17. Formulas based on SERIM Method (6:121-131)

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Vita

Captain Samir Mustafa was born on 26 June 1968 in Anapolis, Brazil. He graduated from Brazilian Air Force Academy (AFA) in 1990. Upon graduation from AFA, he was assigned to Campo Grande Air Force Base. There, Capt Samir worked as a staff member of the flight operations center. In January 1997, Capt Samir was assigned to the Instituto Tecnologico da Aeronautica (ITA), in Sao Jose dos Campos, state of Sao Paulo, were he took a one-year course in systems analysis. Upon his graduation in ITA, he was assigned to the Integrated System of Logistics Materiel and Services Task Force, at the Air Force Galeao Depot Level Maintenance. There, Capt Samir worked as system analyst in the Brazilian Air Force project of an integrated logistics information system. In 1999, Captain Samir was assigned to the Instituto de Logística da Aeronáutica (ILA) in São Paulo city, were he took a six-month course in logistics management. In 2000, he was assigned to a two years master degree program in logistics management at the Air Force Institute of Technology at Wright-Patterson AFB, Ohio. Upon his graduation in 2002 he will be assigned to ILA.

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-- Disclosure of Personal Information is Voluntary --

REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 074-0188*

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From – To)*
26-03-2002	Master's Thesis	March 2001– March 2002

4. TITLE AND SUBTITLE	**5a. CONTRACT NUMBER**
DEVELOPMENT OF A METHOD FOR ASSESSING THE ORGANIZATIONAL, CULTURAL, AND POLITICAL CONSIDERATIONS AFFECTING THE INSERTION OF SILOMS INTO THE MoD	**5b. GRANT NUMBER**
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	**5d. PROJECT NUMBER**
Mustafa, Samir., Captain, BRAF	**5e. TASK NUMBER**
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)	**8. PERFORMING ORGANIZATION REPORT NUMBER**
Air Force Institute of Technology Graduate School of Engineering and Management (AFIT/EN) 2950 P Street, Building 640 WPAFB OH 45433-7765	AFIT/GLM/ENS/02-12
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	**10. SPONSOR/MONITOR'S ACRONYM(S)** **DSCC-CCD**
N/A	**11. SPONSOR/MONITOR'S REPORT NUMBER(S)**

12. DISTRIBUTION/AVAILABILITY STATEMENT

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

In order to handle its obligations, the Brazilian Ministry of Defense (MoD) will need an information system capable of managing logistics information from all military services. A project to develop an integrated information system to fit the requirements of different, but connected, organizations has inherent challenges. Differences in the organizational structures, cultures and political aspects, are key issues to be observed before the development to assure the project's success. The same is applicable when trying to adapt an already existing information system to fill the needs of another organization. In the new organization, it is mandatory to assess the feasibility of the software's alternatives available. Alternatives can be to adapt an existing information system or to develop a completely new system. This research sought to develop a method for assessing the organizational, cultural, and political considerations affecting the insertion of the Integrated Logistics Information System (SILOMS), developed by the Brazilian Air Force, into the MoD. The research develops a method for assisting decision makers in assessing the risks involved in the implementation of an information system in the MoD.

15. SUBJECT TERMS Integrated Logistics Information System, Project Risk Assessment, SILOMS, Risk Taxonomy, Information System Implementation Project

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
					Stephen M. Swartz, Major, USAF
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER** *(Include area code)*
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Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18